Completion Report

THE ROLE OF ENERGY AND MINERAL FUELS IN THE MONTANA ECONOMY

By:

The Montana Energy Advisory Council

Major Contributors:

Theodore H. Clack
Franklin D. Culver
John W. Goers
James H. Nybo

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Foreward

Historically, energy and mineral fuels have played an important role in the Montana economy. As a large watershed of national importance, hydroelectric generation occurs in the Columbia, Missouri and Yellowstone Basins of Montana. Extensive deposits of oil and natural gas have been discovered and developed and the petroleum refining industry is a significant contributor to the economic base of Eastern Montana. Massive coal deposits, important to the early growth of rail transportation, went largely unnoticed following coal's replacement by diesel fuel. With the growth of importance of electricity and the lack of fossil fuels other than coal for generation, the seventies have turned to coal as the major new source of fuel.

Development of Montana's vast coal resources could result in a period of rapid, large-scale social, economic and environmental change. In order to deal effectively with the future, it is desirable to have extensive insight into the role of energy in the economy -- past, present and future.

The purpose of this study is to provide a description and discussion of the historical, present and alternative future roles of energy and mineral fuels in the Montana economy.

Because development of the coal resource is the most significant element on Montana's economic horizon, this study is focussed primarily on the role of this resource in the state's economy, and upon potential impacts of coal development. Due to limitations of time and financial resources, the study has been drawn extensively from secondary sources.

Major support for this study came from the United States Bureau of Mines, Department of the Interior, Contract No. S0133104.

In responding to the objectives of this study, the Montana Energy Advisory Council (MEAC) has become closely involved with the Northern Great Plains Resource Program (NGPRP), and with various relevant research programs within the state. Through its activities, MEAC has influenced the direction of the NGPRP and the content of its interim report. Montana Energy Advisory Council actions also have resulted in the preparation, funding and completion of a number of research projects relevant to the objectives of this study. Several of these have played an important role in the preparation of the final report of this study.

Comprising all state agencies involved in the energy situation, MEAC has the unique opportunity to call upon the full spectrum of information and talent available in state government. This resource pool has been used in the execution of this study.

Major contributors to this effort have been Ted Clack, Frank Culver, John Goers and Jim Nybo. Special thanks are due to Mr. Rod Rosenkranz, Economist with the U.S. Bureau of Mines.

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CHAPTER I.

ENERGY AND THE MONTANA ECONOMY -- PAST AND PRESENT

The Montana Economy

The first trappers and mountain men came to Montana seeking furs and pelts. Later, men came for precious metal mining, copper mining, livestock and dryland farming. Progressing from the 1840's to the 1910's, Montana experiences a period of successive booms. Then came the agricultural depression of the twenties, followed by the great depression of the thirties. Since World War II, the Montana economy has not felt major booms or busts as had been our earlier experience. There have, of course, been scattered highs and lows, and some regular changes. In 1974, our economic base is still singularly dependent on our natural resource base. We still have agriculture -- dryland farming and livestock, mining and metal processing, forestry and wood products, and, more recently, tourism.

Employment and Population

Table I-1 on the following page, based on decennial census data, with sectors broadly aggregated for time series comparability, paints a concise but telling portrait of Montana's population and employment changes since 1930.

Table I-1 State of Montana Population and Employment (1930-1970)

	1930	1940	1950	1960	1970
Population	537,606	559,456	591,024	674,767	694,409
Total Employment	216,471	185,564	218,460	231,260	248,342
Agriculture	79,678	59,083	54,105	39,479	30,866
Construction	8,062	8,838	14,771	14,911	15,674
Forestry	2,978	1,716	884	1,365	2,459
Manufacturing	20,807	12,726	18,515	23,439	23,626
Mining	17,659	13,526	9,342	6,782	5,877
Services & Others	87,287	89,675	120,843	145,284	169,840

Neither total employment nor population have exhibited great growth. From 1930 to 1970, population increased 29 percent and employment grew 15 percent. Table I-2 below shows total civilian employment by sex for 1950, 1960 and 1970.

Table I-2 Total Civilian Employment in Montana by Sex (1950-1970) */

	April 1 1950	April 1 1960	April 1 1970	Percent Change 1950-60	1960-70	1950-70
Males	169,835	163,207	161,654	-4	-1	-5
Females	48,625	68,063	86,688	40	27	78
Total	218,460	231,270	248,342	6	7	14

*/ Montana Economic Study, 1970.

During this period, the number of males employed declined 5 percent, while female employment jumped 78 percent, for a total increase of 14 percent. Johnson reports Montana's job growth as sluggish, and attributes it to the nature of her industry and changes in industry mix. Table I-3 below, from Johnson, portrays primary employment in jobs and percent change for Montana from 1950 to 1970.

Table I-3: Primary Employment in Montana

	Annual Average		
	1950	1960	1970
Agriculture	52,800	39,200	34,800
Mining	10,200	7,900	6,600
Manufacturing	18,000	20,600	23,900
Lumber, wood products and paper	5,400	7,400	8,700
All other manufacturing	12,600	13,200	15,200
Railroads	14,000	9,000	6,600
Federal government, civilian	8,300	9,900	11,900
Total primary employment	103,300	86,600	83,800

	Percent Change		
	1950-60	1960-70	1950-70
Agriculture	-26	-11	
Mining	-23	-16	-34
Manufacturing	14	16	-35
Lumber, wood products and paper.	37	18	33 61
All other manufacturing	5	15	21

Table I-3 Cont'd.

	Percent Change		
	1950-60	1960-70	1950-70
Railroads	-36	-27	-53
Federal government, civilian	19	20	43
Total primary employment	-16	-3	-19

Montana has seen a 19 percent decline in primary jobs in the past two decades. Of course, changes in the primary nature of tourism, as well as other measurement problems, tend to overstate the loss of primary jobs, but in any case, there clearly has been a significant decline in the real and relative magnitude of primary employment in Montana.

But the data indicate that total employment has increased, and it has been in derivative jobs. The shift has been to trade and service industries (wholesaling, retailing, and personal, business, recreational, and professional services); finance, insurance and real estate; construction; nonrail transportation, communication and utility firms; and state and local government. Notable increases from 1950 to 1970 were in services and state and local government.

The Montana Economic Study and Johnson report what they call a "job gap." Thus, in spite of the 14 percent increase in jobs from 1950 to 1970, the increase was far below the growth of the labor force. This two decade job gap has been estimated to amount

to over 35,000 jobs. That is, the state's labor force could have filled 35,000 additional jobs had they been available. Montana generally has an unemployment rate of one percent over the national level. It is likely that the job market has been an important factor in population movements, particularly out-migration.

Table I-4 on the following page is taken directly out of the 1970 census of population, and provides extensive detail as to the industry of employed persons as of the census date.

Table I-4 Industry of Employed Persons by Size of Place: 1970

[Data based on sample, see text. For meaning of symbols, see text]

The State

	Total	Urban				Rural		
		Urbanized areas			Other places of—			
		Total	Central cities	Urban fringe	10,000 or more	2,500 to 10,000	Total	Nonfarm	Farm
EMPLOYED PERSONS 16 YEARS OLD AND OVER									
Total	**344 608**	**135 581**	**49 986**	**45 089**	**4 897**	**43 535**	**42 040**	**109 027**	**76 618**	**32 409**
Agriculture, forestry, and fisheries	32 726	3 488	720	579	141	997	1 771	29 238	7 456	21 782
Mining	5 877	3 486	283	259	24	1 735	1 468	2 391	2 202	189
Construction	15 674	7 928	3 230	2 684	546	2 390	2 308	7 746	6 833	913
Manufacturing	23 626	13 045	5 129	4 619	510	3 039	4 877	10 581	9 253	1 328
Furniture and lumber and wood products	7 236	2 291	60	50	10	980	1 251	4 945	4 407	538
Primary metal industries	4 753	5 216	1 426	1 323	103	245	1 545	1 537	1 372	165
Fabricated metal industries (incl. not specified metal)	1 004	569	289	256	33	67	213	435	397	38
Machinery, except electrical	503	312	155	150	5	113	44	191	163	28
Electrical machinery, equipment, and supplies	113	83	48	48	–	12	22	31	31	–
Motor vehicles and other transportation equipment	344	177	87	77	10	56	40	167	124	43
Other durable goods	1 874	982	345	307	38	232	405	892	769	123
Food and kindred products	3 047	2 064	1 189	1 061	128	430	445	983	759	224
Textile mill and other fabricated textile products	231	126	27	16	11	31	68	105	93	12
Printing, publishing, and allied industries	2 327	1 674	748	690	58	509	417	653	589	64
Chemical and allied products	511	386	111	102	9	168	107	125	106	19
Other nondurable goods (incl. not specified mfg. indus.)	1 683	1 166	644	539	105	196	326	517	443	74
Railroads and railway express service	6 957	4 733	1 012	957	55	1 260	2 461	2 224	2 005	219
Trucking service and warehousing	3 112	2 066	1 170	988	182	375	521	1 046	840	206
Other transportation	1 698	1 027	514	483	31	269	244	671	495	176
Communications	3 106	2 362	817	789	28	912	633	744	693	51
Utilities and sanitary services	4 585	2 842	921	821	100	835	1 086	1 743	1 548	195
Wholesale trade	9 360	6 730	3 635	3 277	358	1 734	1 361	2 630	2 220	410
Food, bakery, and dairy stores	6 312	3 899	1 330	1 191	139	1 186	1 383	2 413	2 147	266
Eating and drinking places	11 379	6 624	2 559	2 233	326	1 923	2 142	4 755	4 248	507
General merchandise retailing	4 968	3 456	1 583	1 431	152	1 011	862	1 512	1 322	190
Motor vehicles retailing and service stations	7 919	4 800	1 772	1 603	169	1 211	1 817	3 119	2 826	293
Other retail trade	14 587	9 426	3 668	3 328	340	2 854	2 904	5 161	4 456	705
Banking and credit agencies	3 899	2 642	1 088	1 006	82	807	747	1 257	1 064	193
Insurance, real estate, and other finance	5 647	4 237	2 082	1 983	99	1 338	817	1 410	1 199	211
Business services	2 075	1 644	963	854	109	395	286	431	391	40
Repair services	3 569	2 023	818	735	83	525	680	1 546	1 355	191
Private households	3 108	1 811	593	535	58	586	632	1 297	1 018	279
Other personal services	9 151	6 072	2 208	1 950	258	1 823	2 041	3 079	2 740	339
Entertainment and recreation services	1 866	1 306	548	475	73	428	330	560	492	68
Hospitals	9 168	6 322	2 063	1 854	209	2 043	2 216	2 846	2 423	423
Health services, except hospitals	5 643	3 417	1 289	1 215	74	1 180	948	2 226	1 960	266
Elementary and secondary schools and colleges	23 604	14 645	4 262	3 975	287	6 872	3 511	8 959	7 478	1 481
Government	20 355	12 364	3 241	3 027	214	6 026	3 097	7 991	6 693	1 298
Private	3 249	2 281	1 021	948	73	846	414	968	785	183
Other education and kindred services	1 454	971	355	330	25	420	196	483	439	44
Welfare, religious, and nonprofit membership organizations	4 288	2 732	972	908	64	1 099	661	1 556	1 362	194
Legal, engineering, and miscellaneous professional services	4 742	3 220	1 281	1 179	102	1 165	774	1 522	1 164	358
Public administration	14 508	8 627	3 121	2 848	273	3 143	2 363	5 881	4 989	892
Male	**159 371**	**82 787**	**30 423**	**27 410**	**3 013**	**25 993**	**26 351**	**76 584**	**38 890**	**35 614**
Agriculture, forestry, and fisheries	29 707	2 982	639	518	121	816	1 527	26 725	6 808	19 917
Mining	5 668	3 338	218	194	24	1 682	1 438	2 330	2 151	179
Construction	14 954	7 428	3 037	2 511	526	2 193	2 198	7 526	6 640	886
Manufacturing	20 918	11 452	4 501	4 065	436	2 644	4 307	9 466	8 289	1 177
Furniture and lumber and wood products	6 901	2 178	55	45	10	945	1 178	4 723	4 211	512
Primary metal industries	4 637	3 127	1 382	1 279	103	245	1 500	1 510	1 350	160
Fabricated metal industries (incl. not specified metal)	809	477	269	236	33	58	150	332	301	31
Machinery, except electrical	448	271	145	140	5	82	44	177	149	28
Electrical machinery, equipment, and supplies	94	77	43	43	–	12	22	17	17	–
Motor vehicles and other transportation equipment	291	161	82	77	5	45	34	130	94	36
Other durable goods	1 559	817	268	235	33	202	347	742	658	84
Food and kindred products	2 519	1 685	988	887	101	328	369	834	624	210
Textile mill and other fabricated textile products	99	61	27	16	11	9	25	38	32	6
Printing, publishing, and allied industries	1 596	1 194	566	529	37	388	240	402	368	34
Chemical and allied products	459	365	107	98	9	160	98	94	75	19
Other nondurable goods (incl. not specified mfg. indus.)	1 506	1 039	569	480	89	170	300	467	410	57
Railroads and railway express service	6 608	4 463	957	907	50	1 178	2 328	2 145	1 932	213
Trucking service and warehousing	2 727	1 797	1 015	851	164	322	460	930	748	182
Other transportation	1 342	825	422	402	20	201	202	517	383	134
Communications	1 732	1 293	458	437	21	494	341	439	419	20
Utilities and sanitary services	3 828	2 340	732	652	80	709	899	1 488	1 328	160
Wholesale trade	7 670	5 444	2 976	2 691	285	1 392	1 076	2 226	1 871	355
Food, bakery, and dairy stores	3 440	2 243	778	701	77	694	771	1 197	1 088	109
Eating and drinking places	3 429	2 211	951	835	116	723	537	1 218	1 130	88
General merchandise retailing	1 423	966	448	418	30	248	270	457	424	33
Motor vehicles retailing and service stations	7 102	4 298	1 586	1 433	153	1 067	1 645	2 804	2 537	267
Other retail trade	8 074	5 179	1 990	1 797	193	1 583	1 606	2 895	2 492	403
Banking and credit agencies	1 448	972	435	409	26	296	241	476	433	43
Insurance, real estate, and other finance	3 490	2 612	1 302	1 230	72	774	536	878	773	105
Business services	1 178	917	514	462	52	259	144	261	236	25
Repair services	3 050	1 704	689	611	78	424	591	1 346	1 186	160
Private households	205	134	64	60	4	43	27	71	67	4
Other personal services	2 893	1 939	700	636	64	641	598	954	839	115
Entertainment and recreation services	978	638	315	267	48	194	129	340	310	30
Hospitals	1 345	899	248	222	26	344	301	446	409	37
Health services, except hospitals	1 738	1 073	424	403	21	386	263	665	598	67
Elementary and secondary schools and colleges	9 920	6 418	1 566	1 481	85	3 355	1 497	3 502	3 145	357
Government	8 778	5 589	1 212	1 146	66	3 022	1 355	3 189	2 869	320
Private	1 142	829	354	335	19	333	142	313	276	37
Other education and kindred services	356	228	61	61	–	139	28	128	122	6
Welfare, religious, and nonprofit membership organizations	2 246	1 329	411	383	28	532	386	917	869	48
Legal, engineering, and miscellaneous professional services	2 204	1 600	594	566	28	638	368	604	541	63
Public administration	9 598	6 045	2 392	2 207	185	2 022	1 631	3 553	3 122	431
EMPLOYED PERSONS 14 AND 15 YEARS OLD										
Total	**3 734**	**1 872**	**815**	**734**	**81**	**558**	**899**	**1 862**	**1 229**	**633**
Agriculture	599	55	21	17	4	10	24	544	98	446
Nonagriculture industries	3 135	1 817	594	517	77	548	675	1 318	1 131	187
Male	**2 383**	**1 175**	**377**	**328**	**49**	**338**	**460**	**1 208**	**755**	**453**
Agriculture	504	43	15	11	4	4	24	461	89	372
Nonagriculture industries	1 879	1 132	362	317	45	334	436	747	666	81

Table I-5: Montana's Total Population From 1930 To 1970, With Percent Change and Compound Growth Rates

Year	Population	Increase	% Increase		Approximate Compound Rate of Growth
1930	537,606	21,850	4.06		2/3%
1940	559,456	31,568	4.64		3/4%
1950	591,024	83,743	14.17	29.17	3/4%
1960	674,767	19,642	2.91		1/4%
1970	694,409				

Table I-5 above reflects Montana's total population changes from census to census from 1930 to 1970. There has been growth, but nothing very strong or significant. Looking at specific areas tells a much more detailed and more revealing story. From 1950 to 1970, 25 of Montana's 56 counties experienced a net increase in population, with 31 declining. From 1960 to 1970, only 15 showed a net increase, with 41 declining. Furthermore, from 1960 to 1970, 46 Montana counties had a net migration loss (more people moved out than moved in) while only ten showed a net increase.

Montana is largely inhabited by white people, with whites accounting for 95.5 percent of the 1970 population. The major non-white component is the widely distributed Indian population.

Income

In the last 50 years, Montana's per capita income has generally been below the national level. The major exception to this was the six-year postwar period from 1947 to 1952, when a combination of good weather and high prices resulted in very high levels of agricultural income. It is interesting to note that while in 1969 Montana's per capita income of $2,712 was 85 percent of the national average, Montana was also shown to have 10.4 percent of all families below the poverty level, compared with 10.7 percent nationwide. In other words, in spite of a smaller per capita income than the nation, Montana's income is distributed such that here there are relatively fewer people living below poverty level.

Structural Changes in the Montana Economy

An in-depth look into the Montana economy leaves several lasting impressions. Montana's economy has been and will continue to be largely dependent on her natural resource base. Many of the most significant factors which determine the health of the primary sectors of the Montana economy are external to our control. These factors include weather, national and world resource and product demands, national programs and policies, out-of-state corporate

control of Montana resources, etc. Montana remains largely a producer of primary products. There has been no significant change, for example, in the relative role played by construction and manufacturing for 25 years.

A review of Montana's post-World War II economic performance will reveal that many changes that have occurred are cyclical, rather than secular. One will discover, for example, that the historical variations in agricultural income have been largely a result of external general economic forces and by more or less random disturbances such as weather. Construction activity in the state has followed a similar pattern. There is no discernable trend in the relative role of contract construction. The major variations that do occur are largely the result of changes in federal government activity with respect to military construction, federal aid highway construction, water resource projects and the like. Otherwise, construction follows the normal mean pattern expected in a rural, "agrarian" environment. Most other sector components of the Montana economy follow similar patterns. Our historical experience suggests that one should only very carefully assign special significance to short-term changes, such as those apparent changes evident during 1971-1974. It is true that Montana has experienced some relative gains during the early 1970's. Not only have the gains been modest, but they are very likely to be

transitory. Virtually all of the recent Montana income gain has been a result of the general inflation of agricultural commodity prices, and to a lesser extent, the prices of other raw materials. From 1972 to 1973, for example, Montana farm income increased by 44.5 percent (about 31 percent in real terms), while non-farm income increased by 10.1 percent (about 4 percent in real terms). 1/

Much of this flavor of the Montana economy can be conveyed through a more detailed look into agriculture. While real income per farm increased by almost 80 percent from 1971 to 1972 and by almost one-third from 1972 to 1973, real income per capita, for the non-farm population actually declined. From 1972 to 1973, this decline was about 2.75 percent. It seems clear that the recent gains in both nominal and real farm income are largely a result of transitory, cyclical forces, and that these gains will not be sustained. According to recent projections by the Department of Commerce, real farm income (total) for Montana would increase by only .5 percent during the decade of the 1970's and by 5.7 percent during the decade of the 1980's. 2/ If this were the case,

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1/ C.f. Survey of Current Business, April 1974.
2/ Ibid.

income increases per farm would come almost entirely through decreases in the number of farms. At the 1964-1969 rate of decline in the number of farms, the average annual rate of increase in real income per farm would amount to about 1.5 percent per year for the next two decades. This would compare to a projected annual increase in real per capita income for the total Montana population of almost three percent per year.

In spite of the dramatic increase in the price of wheat since the latter part of 1972, the price of wheat in real terms (constant dollars as measured by the index of prices paid by farmers) had not risen much above its long-term average by mid-1974. The real price of wheat in Montana for mid-1974 was below that for every year from 1943 to 1954 and also below that for 1936, 1917-1920 and most of the 1924-1928 period. The relevant point here is that the high wheat prices of 1973-74 are mostly the result of cyclical forces that will tend to disappear. Wheat prices are almost certain to return to a narrower variation around historical trend levels, the hungry world and starving people notwithstanding.

The Montana beef cattle industry is in pretty much the same circumstances insofar as long-term prospects are concerned. In real terms, Montana beef cattle prices in mid-1974 were 15 to 20 percent below their historical average. In July 1974, beef cattle prices in constant (1967) dollars were 20 percent below the 1937-74 average and 14 percent below the 1929-1974 average. The average

real price of beef cattle (in 1967 dollars) was about $30 per cwt. in 1973, having reached $37.50 in mid-1973. From this latter peak, the real price had fallen about 50 percent by mid-1974. As is the case with wheat, extreme variations in cattle prices, in either real or nominal terms, are largely a result of cyclical, external, general economic forces. In real terms, present Montana beef cattle prices are abnormally low. One should expect an upward correction of 15 percent to 20 percent, perhaps within the next year or two. Average long-run prospects, however, are another matter.

The reason for this emphasis on wheat and beef cattle in considering the characteristics of the Montana economy is obvious. Cattle and small grains normally account for roughly 85 percent of Montana farm income. Farm income, in turn, accounts for about 15 percent of total Montana personal income (almost 20 percent in 1973). These two agricultural sectors are thus currently responsible for some 13 percent of the state's personal income. While it is not true that Montana's economic fate rests squarely on agriculture, it is true that agricultural and related industries (commonly referred to as "agri-business") exert a tremendous force on the economy.

One should expect the relative importance of agriculture and agricultural business to decline through time, but the decline may not be as rapid as one might suppose. According to the U.S. Department of Commerce projections, the relative share of agriculture

in total personal income would be 10.1 percent in 1990 compared to 11.8 percent in 1971.

In summary, much of our economic base is and will probably continue to be subject to external forces and cyclical variations largely out of our control.

Energy Flows and Historic Production and Consumption

It is meaningful to pursue Montana energy flows from two different viewpoints. This section first provides a comparison of Montana energy production by fuel source with in-state consumption of each energy form. Gross energy flows in terms of net export or net import relationships are thus derived. Montana energy flows are then treated in terms of major sectors of in-state consumption.

Interstate Energy Flows

The United States is a large net importer (consumption exceeds domestic production) of natural gas and petroleum. On a net basis, the nation exports about ten percent of its total domestic coal production. Conversely, Montana consumes less coal, electricity and petroleum than it produces. Only for natural gas does Montana consumption exceed in-state production.

Montana, in fact, exports natural gas, but not at levels sufficient to balance imports of natural gas from Canada. While the state has been a net exporter of significant amounts of electrical

energy, much electricity generated in Montana is from federal hydroelectric projects and is committed to federal distribution systems.

Tables I-6, I-7, I-8 and I-9[3/] show 1960-1971 Montana production, consumption and net flow data for coal, petroleum, natural gas and electricity, respectively.

Table I-6 : Production, Consumption and Outflow of Coal From Montana, 1960-1971

	Production		Consumption		Net Outflow */	
Year	Thousand Short Tons	Trillion BTU	Thousand Short Tons	Trillion BTU	Thousand Short Tons	Trillion BTU
1960	310.0	5.3	419.7	7.1	-106.7	-1.8
1961	371.0	6.4	429.2	7.3	- 58.2	- .9
1962	382.0	6.5	443.9	7.5	- 61.9	-1.0
1962	343.0	5.8	466.5	7.9	-123.5	-2.1
1964	346.0	5.9	499.4	8.5	0153.4	-2.6
1965	364.0	6.2	546.5	9.3	-182.5	-3.1
1966	419.0	7.1	584.0	9.9	-165.0	-2.8
1967	371.0	6.4	631.7	10.7	-260.7	-4.3
1968	519.0	8.8	690.4	11.7	-171.4	-2.9
1969	1,030.0	17.5	761.9	13.0	268.1	+4.5
1970	3,447.0	58.6	848.3	14.5	2,598.7	+44.1
1971	7,064.0	120.0	952.0	16.2	6,112.0	+103.8

*/ Negative figures indicate consumption greater than production.

3/ Northern Great Plains Resource Program, National and Regional Energy Considerations Work Group Report, February 1974, pp. I-30 through I-33.

Table I-7 : Production, Consumption and Outflow of Petroleum From Montana, 1960-1971

	Production		Consumption		Net Outflow	
Year	Thousand Barrels	Trillion BTU	Thousand Barrels	Trillion BTU	Thousand Barrels	Trillion BTU
1960	30,758.0	174.6	21,100.0	120.9	9,658.0	53.7
1961	31,455.0	181.5	21,391.0	120.7	10,064.0	60.8
1962	32,088.0	185.2	21,724.0	120.8	10,364.0	64.4
1963	31,372.0	178.8	22,097.0	121.2	9,275.0	57.6
1964	31,132.0	174.8	22,505.0	121.9	8,627.0	52.9
1965	33,255.0	185.5	22,973.0	123.0	10,282.0	62.5
1966	35,909.0	200.2	23,087.0	124.4	12,822.0	75.8
1967	35,977.0	201.2	23,260.0	126.2	12,647.0	75.0
1968	49,333.0	274.6	23,494.0	128.3	25,839.0	146.3
1969	44,482.0	248.6	23,798.0	130.8	20,684.0	117.8
1970	38,479.0	215.7	24,181.0	133.8	14,298.0	81.9
1971	35,149.0	196.9	24,648.0	137.5	10,501.0	59.4

Table I-8 : Production, Consumption and Outflow of Natural Gas From Montana, 1960-1971

	Production		Consumption		Net Outflow */	
Year	Million Cubic Feet	Trillion BTU	Million Cubic Feet	Trillion BTU	Million Cubic Feet	Trillion BTU
1960	33,418.0	34.5	53,815.0	55.7	-20,397.0	-21.2
1961	33,901.0	34.9	56,393.0	58.5	-22,492.0	-23.6
1962	29,955.0	30.9	62,452.0	64.9	-32,497.0	-34.0
1963	30,026.0	31.0	64,892.0	67.5	-34,866.0	-36.5
1964	25,051.0	25.8	67,045.0	69.9	-41,994.0	-44.1
1965	28,105.0	29.0	69,533.0	72.0	-41,428.0	-43.0
1966	30,685.0	31.6	74,087.0	77.1	-43,402.0	-45.5
1967	25,866.0	26.7	75,163.0	78.0	-49,297.0	-51.3
1968	19,313.0	19.9	79,043.0	82.0	-59,730.0	-62.1
1969	41,229.0	42.5	83,896.0	86.9	-42,667.0	-44.4
1970	42,705.0	44.0	89,095.0	92.0	-46,390.0	-48.0
1971	32,720.0	33.7	92,016.0	94.9	-59,296.0	-61.2

*/ Negative figures indicate consumption greater than production.

Table I-9: Generation, Sales and Outflow of Electricity in Montana, 1960-1971

Year	Net Generation		Sales		Net Outflow */	
	Million KW Hr.	Trillion BTU	Million KW Hr.	Trillion BTU	Million KW Hr.	Trillion BTU
1960	5,992	20.4	5,111	17.4	881	3.0
1961	6,780	23.1	5,246	17.9	1,534	5.2
1962	7,051	24.1	5,552	18.9	1,499	5.2
1963	6,595	22.5	5,729	19.5	866	3.0
1964	7,360	25.1	6,241	21.3	1,119	3.8
1965	8,882	30.3	6,893	23.5	1,989	6.8
1966	8,611	29.4	7,794	26.6	817	2.8
1967	9,119	31.1	7,532	25.7	1,587	5.4
1968	9,495	32.4	8,559	29.2	936	3.2
1969	10,444	35.6	10,098	34.5	346	1.1
1970	10,026	34.2	10,007	34.1	19	.1
1971	10,653	36.3	10,141	34.6	512	1.7

*/ Difference of sales and net generation of electricity. Kilowatt-hours converted to British Thermal Units (BTU) using a rate of 3,412 BTU/KW Hr.

Intrastate Energy Flows

Tables I-10 and I-11, I-12 and I-13, I-14 and I-15, and I-16 and I-17 4/ are paired, expressing 1960-1971 Montana energy consumption in electrical generation, industrial, transportation and household

4/ Ibid., first draft, Appendix VI.

sectors, first in standard units and second in trillion BTU equivalents.[5/]

Electrical Generation: As noted in Table I-11, coal and natural gas are essentially the only fossil fuels consumed in Montana electrical generation. Petroleum products are generally used only for boiler start-up purposes.

Two Montana power plants burn coal. Montana Power's Corette Plant (Billings) is rated at 172.8 megawatt capacity and consumes an estimated 500,000 tons of subbituminous coal annually at 1972-1973 load factors. Montana-Dakota Utilities' Lewis and Clark Plant (Sidney) is rated at 50 megawatts capacity and consumes approximately 320,000 tons of lignite annually.

5/ In Tables I-6, I-11, I-13 and I-17, it appears that BTU values assumed for converting tons of coal into trillion BTU were too high. To be equivalent to the reported BTU values, the coal consumed would vary between 10,000 and 12,400 BTU per pound. Recalculation of the tables would be quite complex as markedly different BTU values have to be assigned coal for each consumption sector and within consumption sectors, BTU values undoubtedly changed with time. For example, the reported figures for coal BTU's consumed in electrical generation assume heat contents of 11,400 to 12,000 BTU per pound. Yet, in the early sixties, the only coal consumed in Montana steam generation plants was 7,000 BTU coal from Knife River's Savage Mine. In the late sixties, 8,600 BTU coal began to be consumed at the Corette Plant near Billings. Coal used in the household sector ranged from 7,000 BTU lignite to 11,500 BTU subbituminous from small underground mines in the Roundup area. Most household coal came from Roundup. Thus, reported coal BTU's for the household sector are much more accurate. In that overall BTU percentages between various fuels in given consumption sectors would be only slightly altered, the NGPRP tables are presented unedited.

Table I-10: Consumption of Energy Inputs in the Electricity Generation Sector, Montana, 1960-1971

Year	Bituminous Coal & Lignite Thousand Short Tons	Petroleum Products Thousand Barrels	Natural Gas Million Cubic Feet	Hydropower & Nuclear Power Million KW Hr.
1960	187.0	2.2	341.0	5,801.0
1961	205.0	0.0	356.0	6,499.0
1962	225.0	0.0	3,712.0	6,410.0
1963	247.0	0.0	3,303.0	6,012.0
1964	271.0	0.0	2,450.0	6,821.0
1965	296.0	0.0	1,785.0	8,389.0
1966	347.0	0.0	2,977.0	7,940.0
1967	407.0	0.0	502.0	8,704.0
1968	477.0	0.0	631.0	8,925.0
1969	559.0	0.0	1,520.0	9,449.0
1970	655.0	0.0	2,529.0	8,745.0
1971	768.0	0.0	1,075.0	9,595.0

Table I-11: Consumption of Energy Inputs in the Electricity Generation Sector, Montana, 1960-1971 (Trillion BTU)

Year	Bituminous Coal & Lignite	Petroleum Products	Natural Gas	Total Fossil Fuels	Hydropower & Nuclear Power	Total Gross Energy
1960	3.2	0	0.4	3.6	62.4	66.0
1961	3.5	0	0.4	3.9	69.2	73.1
1962	3.8	0	3.8	7.6	67.7	75.3
1963	4.2	0	3.4	7.6	63.0	70.7
1964	4.6	0	2.5	7.1	71.4	78.5
1965	5.0	0	1.8	6.8	87.7	94.5
1966	5.9	0	3.1	9.0	82.7	91.7
1967	6.9	0	0.5	7.4	90.8	98.2
1968	8.1	0	0.7	8.7	92.0	101.6
1969	9.5	0	1.6	11.1	98.7	109.8
1970	11.1	0	2.6	13.7	91.8	105.5
1971	13.0	0	1.1	14.1	98.3	112.4

Table I-12: Consumption of Energy Inputs in the Industrial Sector, Mt., 1960-1971

Year	Bituminous Coal & Lignite Thousand Short Tons	Petroleum Products Thousand Barrels	Natural Gas Million Cubic Feet	Utility Electricity Distributed Million KW Hr.
1960	8.4	1,536.0	24,186.0	3,334.0
1961	13.4	1,336.0	25,782.0	3,369.0
1962	20.8	1,162.0	27,484.0	3,517.0
1963	33.3	1,011.0	29,298.0	3,566.0
1964	53.3	880.0	31,323.0	3,954.0
1965	84.1	773.0	33,304.0	4,439.0
1966	74.8	920.0	35,535.0	5,249.0
1967	66.6	1,096.0	37,916.0	4,820.0
1968	59.3	1,305.0	40,456.0	5,661.0
1969	52.7	1,554.0	43.167.0	7,046.0
1970	46.9	1,851.0	46,059.0	6,816.0
1971	42.0	2,206.0	49,068.0	6,772.0

Table I-13: Consumption of Energy Inputs in the Industrial Sector, Montana, 1960-1971 (Trillion BTU)

Year	Bituminous Coal & Lignite	Petroleum Products	Natural Gas	Total Fossil Fuels	Total Gross Energy	Utility Electricity Distributed	Total Net Energy Inputs
1960	0.1	9.3	25.0	34.4	34.4	11.4	45.8
1961	0.2	7.9	26.7	34.8	34.8	11.5	46.3
1962	0.4	6.7	28.5	35.6	35.6	12.0	47.6
1963	0.6	5.7	30.4	36.7	36.7	12.2	48.9
1964	0.9	4.8	32.4	38.1	38.1	13.5	51.6
1965	1.4	4.2	34.5	40.1	40.1	15.1	55.2
1966	1.3	5.1	36.7	43.1	43.1	18.0	61.1
1967	1.1	6.2	39.1	46.4	46.4	16.5	62.9
1968	1.0	7.5	41.7	50.2	50.2	19.3	69.5
1969	0.9	9.1	44.5	54.5	54.5	24.1	78.6
1970	0.8	11.0	47.4	59.2	59.2	23.2	82.4
1971	0.7	13.1	50.5	64.3	64.3	23.1	87.4

Table I-14: Consumption of Energy Inputs in the Transportation Sector, Montana, 1960-1971

Year	Bituminous Coal & Lignite Thousand Short Tons	Petroleum Products Thousand Barrels	Natural Gas Million Cubic Feet	Utility Electricity Distributed Million KW Hr.
1960	0	11,448.0	485.0	99.0
1961	0	11,837.0	473.0	91.0
1962	0	12,239.0	461.0	100.0
1963	0	12,655.0	449.0	97.0
1964	0	13,085.0	438.0	83.0
1965	0	13,551.0	426.0	94.0
1966	0	13,632.0	468.0	97.0
1967	0	13,714.0	515.0	90.0
1968	0	13,796.0	567.0	76.0
1969	0	13,878.0	624.0	63.0
1970	0	13,961.0	687.0	80.0
1971	0	14,047.0	760.0	88.0

Table I-15: Consumption of Energy Inputs in the Transportation Sector, Montana, 1960-1971 (Trillion BTU)

Year	Bituminous Coal & Lignite	Petroleum Products	Natural Gas	Total Fossil Fuels	Total Gross Energy	Utility Electricity Distributed	Total Net Energy Inputs
1960	0	62.0	0.5	62.5	62.5	0.3	62.8
1961	0	64.0	0.5	64.5	64.5	0.3	64.8
1962	0	66.1	0.5	66.6	66.6	0.3	66.9
1963	0	68.3	0.4	68.7	68.7	0.3	69.0
1964	0	70.6	0.4	71.0	71.0	0.3	71.3
1965	0	73.0	0.4	73.4	73.4	0.3	73.7
1966	0	73.5	0.5	74.0	74.0	0.3	74.3
1967	0	74.1	0.6	74.7	74.7	0.3	75.0
1968	0	74.6	0.7	75.3	75.3	0.3	75.6
1969	0	75.1	0.8	75.9	75.9	0.2	76.1
1970	0	75.6	0.9	76.5	76.5	0.3	76.8
1971	0	76.4	1.0	77.4	77.4	0.3	77.7

Table I-16: Consumption of Energy Inputs in the Household Sector, Montana, 1960-1971

Year	Bituminous Coal & Lignite Thousand Short Tons	Petroleum Products Thousand Barrels	Natural Gas Million Cubic Feet	Utility Electricity Distributed Million KW Hr.
1960	224.3	2,481.0	28,803.0	1,678.0
1961	210.8	2,501.0	29,782.0	1,786.0
1962	198.1	2,521.0	30,795.0	1,935.0
1963	186.2	2,542.0	31,842.0	2,066.0
1964	175.1	2,563.0	32,925.0	2,204.0
1965	166.4	2,587.0	34,018.0	2,360.0
1966	162.2	2,776.0	35,107.0	2,447.0
1967	158.1	2,979.0	36,230.0	2,622.0
1968	154.1	3,196.0	37,389.0	2,822.0
1969	150.2	3,429.0	38,585.0	2,989.0
1970	146.4	3,679.0	39,820.0	3,111.0
1971	142.0	3,935.0	41,113.0	3,281.0

Table I-17: Consumption of Energy Inputs in the Household Sector, Montana, 1960-1971 (Trillion BTU)

Year	Bituminous Coal & Lignite	Petroleum Products	Natural Gas	Total Fossil Fuels	Total Gross Energy	Utility Electricity Distributed	Total Net Energy Inputs
1960	3.8	13.4	29.8	49.2	49.2	5.7	54.9
1961	3.6	13.5	30.9	50.1	50.1	6.1	56.2
1962	3.4	13.6	32.1	51.1	51.1	6.6	57.7
1963	3.2	13.7	33.3	52.1	52.1	7.0	59.1
1964	2.3	13.8	34.6	53.2	53.2	7.5	60.7
1965	2.8	14.0	35.3	53.8	53.8	8.1	61.9
1966	2.8	15.1	36.8	56.3	56.3	8.3	64.6
1967	2.7	16.3	37.8	58.4	58.4	8.9	67.3
1968	2.6	17.6	38.9	60.7	60.7	9.6	70.3
1969	2.6	19.0	40.0	63.1	63.1	10.2	73.3
1970	2.5	20.6	41.1	65.6	65.6	10.6	76.2
1971	2.4	22.4	42.3	68.4	68.4	11.2	79.6

Table I-18: Electric Energy Sales, By Class of Service, Montana (In Million Kilowatt Hours)

		Class of Service		
Year	Total	Residential	Commercial	Industrial
1972	8,900	1,800	1,100	5,900
1971	8,890	1,633	990	5,999
1970	8,750	1,534	924	6,029
1969	8,786	1,468	863	6,208
1968	7,433	1,373	805	4,982
1967	6,596	1,291	739	4,273
1966	6,902	1,261	698	4,675
1961	4,697	982	518	2,975

Table I-19: Change in Electric Sales by Year, by Class of Service, in Percent (1972-1966)

		Class of Service		
Year	Total	Residential	Commercial	Industrial
1972-71	+ 0.1	+10.2	+11.1	- 1.7
1971-70	+ 1.6	+ 6.5	+ 7.1	- 0.5
1970-69	- 0.5	+ 4.5	+ 7.1	- 2.9
1969-68	+18.2	+ 6.9	+ 7.2	+24.6
1968-67	+12.7	+ 6.4	+ 8.9	+16.6
1967-66	- 4.5	+ 2.4	+ 5.9	- 8.6

Montana Power's Frank Byrd Plant (Billings) is rated at 69 megawatts capacity, is operated intermittently to meet peak demands, and accounts for all the natural gas consumption reported in Table I-11.

Montana has no nuclear generation capacity. Accordingly, the consumption reported in the last column of Table I-11 is entirely attributable to hydropower. Table I-12 indicates that Montana hydrogeneration produced over five times the electrical energy in 1971 as did all fossil fuel plants combined.

Industrial Sector: Most industrial coal consumption in Montana is by sugar beet refineries. For the period 1960-1971, coal accounted for one to three percent of total industrial energy consumption (Table I-12).

Petroleum and natural gas consumption is attributable to a variety of Montana industries, notably copper smelting, lead smelting, cement manufacture and forest products (wood drying kilns, particle board, plywood and paper).

Industrial consumption of electrical energy is largely attributable to electrolytic refining of copper and aluminum. One such facility, Anaconda Aluminum's Columbia Falls aluminum reduction works, is consuming 370 megawatts at full production levels. The aluminum reduction process requires a steady flow of electricity, 24 hours a day, 365 days a year. Operating at 80 percent capacity in 1972, the Columbia Falls plant consumed 3.072 billion kilowatt

hours of electricity. This compares to total Montana electrical energy consumption of less than 11 billion kilowatt hours.

Transportation Sector: Petroleum products (diesel fuel, gasoline, aviation fuel) account for 98 to 99 percent of the total energy consumed in the Montana transportation sector. Electricity consumed in transportation is almost entirely attributable to the remaining electrified sections of the Milwaukee Railroad. The Milwaukee road is presently in the process of replacing all remaining electric locomotives and relying entirely on diesel powered units.[6/]

Household Sector: The household sector includes energy consumed by commercial interests as well as dwelling places. Natural gas accounts for over half the energy consumed in the household sector. Petroleum products used in space heating account for over one-quarter of Montana's total household consumption. Coal consumption for home heating has decreased each successive year. On a BTU equivalent basis, electrical energy accounts for just over one-eighth of household energy consumed.

6/ MEAC was unable to substantiate the relatively high NGPRP figures for natural gas consumption in the transportation sector. Some bottle gas is consumed by railroad refrigerator cars. The Montana Motor Transport Association reports only minimal use of propane and butane in the trucking industry.

Recent Consumption Trends: Total Montana energy consumption grew at an average annual rate of 3.2 percent, significantly lower than national and regional averages. Recently, however, price increases, spot fuel shortages, concern about availability of hydropower during the winter of 1973-74, and a strengthened conservation ethic have either reduced or reversed growth in consumption of various energy forms.

Montana gasoline consumption data recently compiled by the Environmental Quality Council (a MEAC member agency) are presented below:

Table I-20: Montana Gasoline Consumption (1971-1974)

Year	Gasoline Consumption (Million Gallons)	Percent of Change
1971	408.969	
1972	435.025	6.3
1973	462.181	5.9
1973 (1st 8 mo.)	313.228	
1974 (1st 8 mo.)	300.520	-4.2

The marked drop in gasoline consumption can be attributed to the 55 m.p.h. speed limit implemented in March 1974 and to an organized conservation effort. Before the speed limit was imposed, voluntary energy conservation measures reduced gasoline consumption only two percent below 1973 levels. Reductions in total petroleum

consumptions are assumed to be significantly smaller than those for gasoline alone. Up-to-date total petroleum consumption data are not available.

Petroleum Production and Refining Trends

Figure I-1 7/ shows 1942-1973 daily Montana crude oil production by producing region. The sharp 1968 production peak reflects initial yields from the newly discovered Bell Creek field in Southeastern Montana (Powder River County). In each producing area, production is either steady due to oil and gas conservation measures (production controls) or is decreasing as oil fields are depleted. Unless production is being artificially held back by factors beyond the scope of this report, it appears Montana oil production will not increase markedly unless new fields are discovered.

Montana's 1973 natural gas production was 57.7 billion cubic feet, up 65 percent from the 35 billion cubic feet produced in 1972. This marked increase is attributable to the Tiger Ridge Field of North Central Montana (see Figure I-2) which went on stream in November 1972. As with crude oil, future increases in gas production will likely depend on new discoveries.

Introductory portions of Section II of this report deal with trends in oil and gas exploration.

7/ Montana Oil and Gas Conservation Division 1973 Annual Review, p. 8.

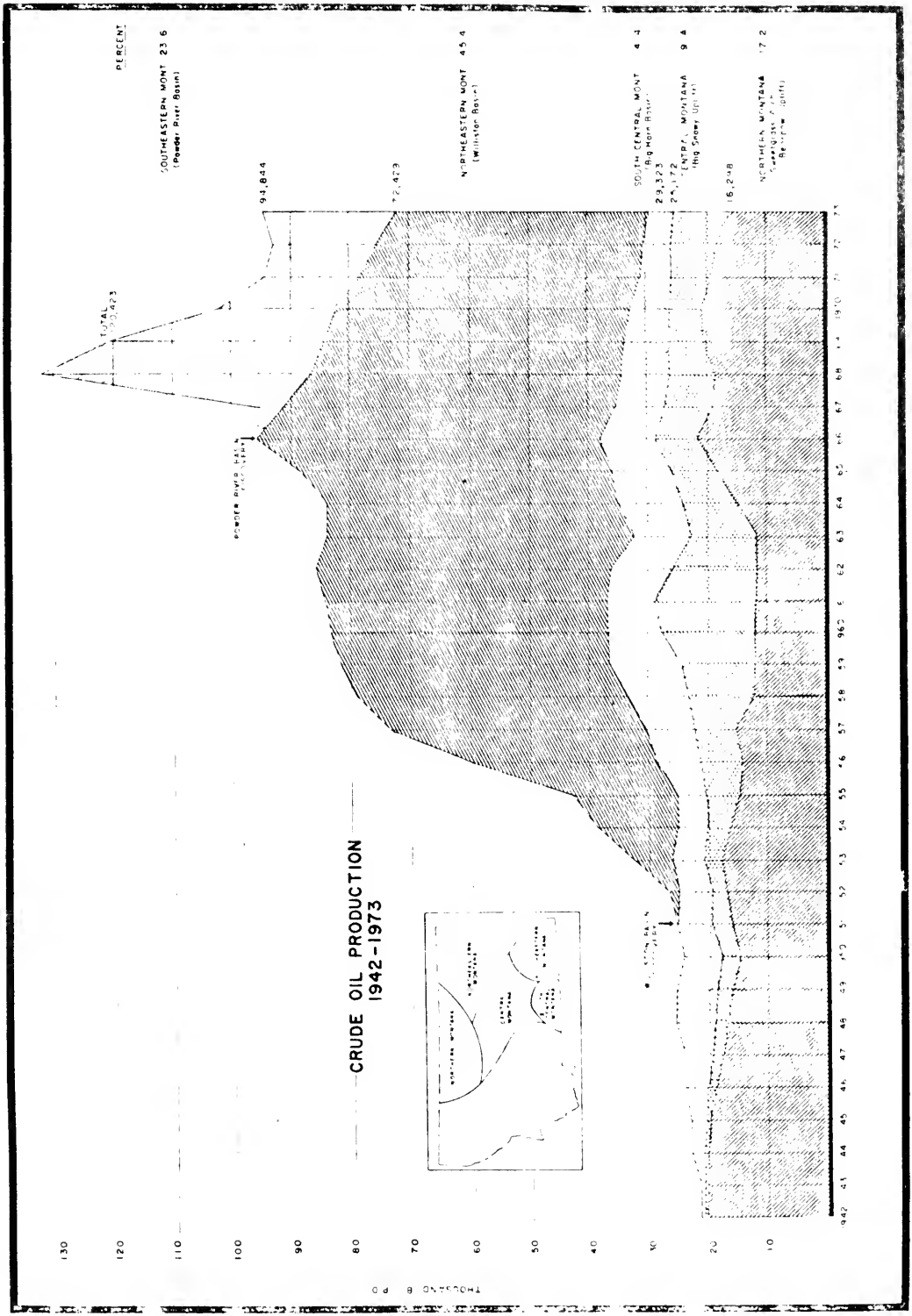
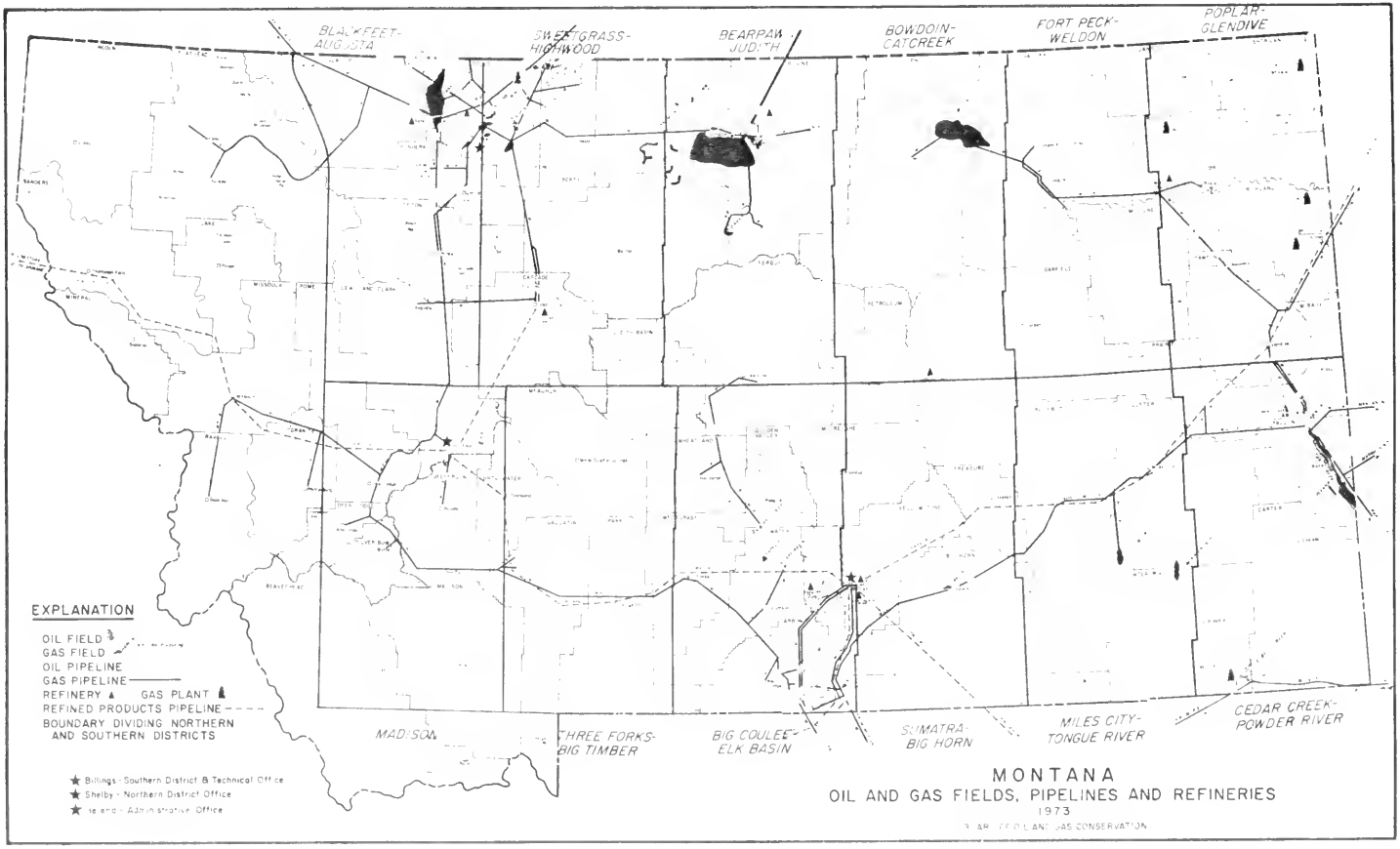

CRUDE OIL PRODUCTION
1942-1973
PERCENT
SOUTHEASTERN MONT 23 6
(Powder River Basin)
NORTHEASTERN MONT 45 4
(Williston Basin)
SOUTH CENTRAL MONT 4 4
(Big Horn Basin)
CENTRAL MONTANA 9 4
(Big Snowy Uplift)
NORTHERN MONTANA 17 2
(Sweetgrass Arch-Bearpaw Uplift)
94,844
72,423
29,323
24,172
16,248
THOUSANDS B P D

Figure I-1


BLACKFEET-AUGUSTA
SWEETGRASS-HIGHWOOD
BEARPAW JUDITH
BOWDOIN-CATCREEK
FORT PECK-WELDON
POPLAR-GLENDIVE
MADISON
THREE FORKS-BIG TIMBER
BIG COULEE-ELK BASIN
SUMATRA-BIG HORN
MILES CITY-TONGUE RIVER
CEDAR CREEK-POWDER RIVER
EXPLANATION
OIL FIELD
GAS FIELD
OIL PIPELINE
GAS PIPELINE
REFINERY ▲ GAS PLANT
REFINED PRODUCTS PIPELINE
BOUNDARY DIVIDING NORTHERN AND SOUTHERN DISTRICTS
★ Billings - Southern District & Technical Office
★ Shelby - Northern District Office
★ Helena - Administrative Office
MONTANA
OIL AND GAS FIELDS, PIPELINES AND REFINERIES
1973
BUREAU OF OIL AND GAS CONSERVATION

Montana has nine petroleum refineries, two of which are small and produce special products only. In 1973, Montana refineries processed nearly 51 million barrels of crude petroleum. In 1968, 1970, 1971 and 1972, Montana refineries processed 40.4, 42.3, 45.0 and 48.5 million barrels, respectively.

Table I-21 below provides a refinery-by-refinery breakdown of 1973 crude oil inputs.[8/]

Table I-21: Montana Refining
(1973)

Company	Total Bbls. Processed
Big West Oil Company (Kevin)	1,469,405
Continental Oil Company (Billings)	16,488,321
Diamond Asphalt Company (Chinook)	3,069
Farmers Union Central Exchange, Inc. (Laurel)	11,921,953
Exxon Company (Billings)	16,668,281
Jet Fuel Refinery (Mosby)	6,982
Phillips Petroleum Company (Great Falls)	2,219,519
Spruce Oil Company (Wolf Point)	668,318
Westco Refining Company (Cut Bank)	1,521,358
	50,967,206

8/ Ibid., p. 4.

Montana crude oil production for 1973 was 34.6 million barrels. Comparing that production and production reported in Table I-7 of this report with volumes of crude processed at Montana refineries, it becomes obvious that "imported" crude oil supports significant portions of the Montana refining industry. Montana refineries receive large volumes of crude oil, both from Wyoming and the Dominion of Canada. Assuming that crude supplies remain stable, Montana refineries are expected to continue modest annual increases in crude oil processed.

Figure I-2 shows the location of Montana's oil refineries, gas processing plants, crude oil pipelines, refined product lines and natural gas lines.

Coal Production Trends

Figure I-3 [9/], "Coal Production in the Rocky Mountain Region, 1925-1963" graphically portrays the marked decline in Montana coal production from the World War II Era until the Mid-1960's. Until the Lewis and Clark and Corette coal-fired electrical generation plants came on line in 1958 and 1967, respectively, almost all Montana coal production was for railroad use. The Great Falls-

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9/ "Montana's Place in the Nation's Coal Energy Picture", Montana Bureau of Mines and Geology, 1967. (Paper presented by Dr. S. L. Groff at the Grand Forks, North Dakota, Lignite Symposium, April 27, 1967.)

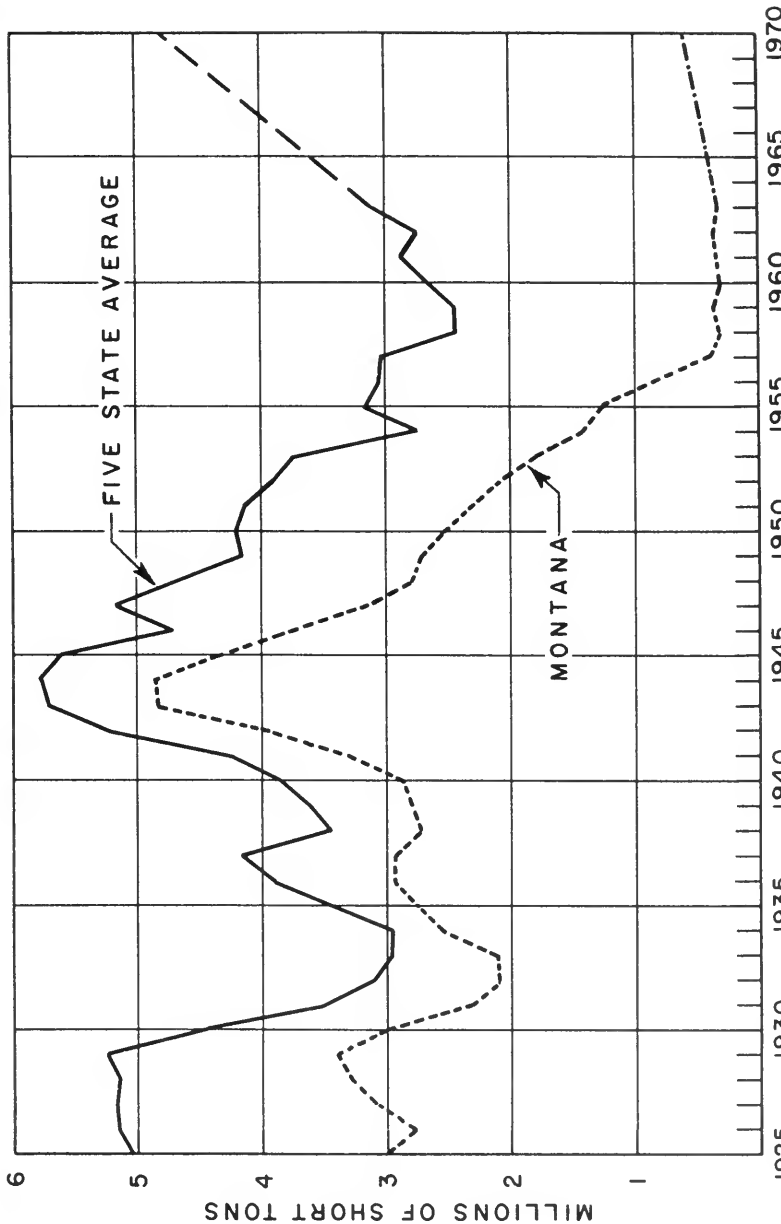


Figure I-3: Coal production in the Rocky Mountain region, 1925 to 1963, and estimated production projected to 1970. Average of North Dakota, Wyoming, Utah, Colorado, and New Mexico compared to Montana. (modified from Averitt, 1965)

Lewistown coal field supplied the Great Northern Railroad and the Northern Pacific was supplied by company mines at Colstrip, now owned by the Western Energy Company, a subsidiary of Montana Power.

Table I-22, prepared by the Montana Energy Advisory Council (MEAC) provides more recent coal production data and differ slightly from the NGPRP production figures given in Table I-6. The MEAC compilation is from corporate production reports filed with the Montana Department of Revenue and are believed highly reliable. The recent production figures reflect an acceleration of Montana coal exports to the Midwest.

Table I-22: Montana Coal Production in Tons 1967 - 1973

1967	355,961	1971	7,071,526
1968	507,125	1972	8,243,647
1969	1,018,270	1973	10,821,413
1970	3,511,778		

As of the Fall of 1974, three major Montana strip mines (Peabody near Colstrip, Decker Coal near Decker, and Westmoreland Resources in the Sarpy Basin) produce coal that is almost entirely committed to midwestern utilities. Western Energy's Colstrip mine supplies the Corette power plant at Billings, but exports most of

its coal to the Midwest as well. Only the Knife River coal mine near Savage produces exclusively for in-state utility consumption.

Energy -- As a Factor of Production

Although virtually everyone living in America today is a final consumer of energy in one form or another, most of the non-energy goods and services we consume require energy in their production and delivery to us. This section will review the role of energy as a factor in the production of goods and services. First, a general look at the total situation followed by brief profiles of several of the major industrial energy users in Montana.

Electricity:

Table I-23: Commercial and Industrial Electricity Consumption (Sales) In Montana By Selected Years (in millions of kilowatt hours)

	1960	1965	1970
Commercial	480	654	924
Industrial	2,951	3,938	6,029

Mineral Industries: Formerly accounting for 15 percent of the Montana employed labor force, the mineral industries now employ approximately 5 percent of all persons now at work in Montana. Despite this, the mineral industries are still one of Montana's important basic industries. This is especially true in those areas of the state in which minerals production is the only, or one of the very few, basic industries. Such cities as Butte, and Anaconda, Montana, are totally dependent upon the health of the Anaconda Copper Company. Columbia Falls, Montana, site of the Anaconda Aluminum Reduction Works, is almost completely dependent upon the fortunes of that industry for its economic well-being. Billings, Montana, while presenting a more diversified economy, depends significantly upon the oil refining industry.

The largest share of jobs in the minerals industries are provided by metals mining, smelting and refining. Second to the metals industry ranks the petroleum industry. The remaining jobs in the minerals industries are primarily those associated with small operations scattered around the state. These latter operations produce sand and gravel, phosphate rock, fluorspar, talc, bentonite and other minerals. 10/

10/ Material taken from Montana Economic Study, Part 2: The Industries of Montana, Volume 1.

The availability of large amounts of energy is very important to the minerals industry, particularly to its smelting and refining sectors. Mining operations have become increasingly capital and energy intensive. The smelting and refining processes have traditionally been energy consumptive.

The smelting process is a pyrolytic one. For example, copper ore, once crushed, is roasted to convert its essentially sulfide form to various copper oxides. Subsequently, the roasted ore is subjected to intense heat, resulting in a copper melt. Beyond this stage, the copper is refined by electrolytic processes, requiring large quantities of electricity. The roasting and smelting phases require great heat, provided by combustion of natural gas.

Aluminum refining is a major consumer of electricity. The refined aluminum ore, bauxite, is subjected to great heat, providing a melt. The melt is then purified by electrolytic means. Both phases of the process require electricity.

Oil refining, a distillation process, also requires copious amounts of energy. In this case, one of the petroleum fractions is burned to provide the heat necessary to distill other factions of the crude feedstock.

Anaconda Aluminum Reduction Works:

Dedicated in 1955, this plant now employs over 900 persons and produces 68,750 tons of aluminum per year. As the aluminum

reduction process requires vast amounts of electricity, the plant was located in close proximity to a Bonneville Power Administration hydroelectric facility. In 1973, the reduction works consumed over 2,318,006 thousand kilowatt hours of electric power, nearly 30 percent of all electricity consumed in Montana. 1972 consumption of electricity totalled 3,072,540 thousand kilowatt hours. Much of the disparity in consumption of electricity between 1972 and 1973 can be attributed to a curtailment of interruptible power due to drought conditions within the Bonneville Power Administration hydroelectric system in the Pacific Northwest.

Our sources for the reduction works have shifted from Texas and Arkansas to Jamaica. The low cost power from the BPA network offsets the high costs associated with transporting the ore.

Although, according to the Montana Economic Study, the aluminum plant has provided badly needed jobs in Flathead County and Columbia Falls, it has been a major source of severe environmental degradation.

Anaconda Copper Works: The Anaconda Copper operations combine plants in Butte and Anaconda. Until recently, reduction works also operated in Great Falls and East Helena, Montana. However, the Anaconda Company closed its East Helena operation and its zinc refinery in Great Falls, though the Great Falls plant may be expanded in the near future. The closure of the electrolytic plant in Great Falls reduced Anaconda's demand for electric power.

Much of the energy now used by the Anaconda operations in the smelting process is natural gas. The vast majority of the state's copper and silver output comes from the Anaconda Company's operations in Butte and Anaconda. Ore concentrates from the Butte mines and from Nevada are processed at the Anaconda smelter.

The Anaconda Company has announced plans to build an arbiter plant in Anaconda, Montana, in the very near future. This expansion of their works will increase their production and decrease the environmental impact of their operations. The use of the arbiter process will increase Anaconda's consumption of electric power considerably. Recent agreements between the state and the Anaconda Company regarding plant emissions will result in additional consumption of electricity as existing operations are cleaned up.

American Smelting and Refining Company: A small smelter operated by ASARCO is located in East Helena, Montana. Although the operation is said to be marginal, agreements have recently been made between the ASARCO and Montana to clear up plant emissions. This will result in an increase in electric power consumption at that site. The primary energy source of the present operation is natural gas.

Although the ASARCO operation is small and does only custom smelting of ores from numerous Rocky Mountain areas, it does

account for an estimated 600 primary and derivative jobs in the East Helena area.

Non-metallic, Non-fuel Mineral Industries: This sector of the mineral industries is a small one, accounting for only 700-1000 workers. Despite its size, the value of its product is high, and the wage level of related workers is well above median state wage for industrial workers. The largest employer among this sector is the chemical and fertilizer minerals group, with total employee population of about 500 persons. Related chemical plant employees number an additional 350-400 persons.

The Stauffer Chemicals works is the largest energy consumer and employer among this group of industrial plants. This plant, located at Ramsay, Montana, produces elemental phosphorus from ores mined in Idaho. As was the case with the Anaconda aluminum, the plant was located in Ramsay due to the availability of relatively low cost power. The Stauffer works consumed 379,957 thousand kilowatt hours of electric power in 1973, down from the 1972 total of 412,580 thousand kilowatt hours.

Oil Refining: Some nine refineries operate in Montana. Of these refineries, three, located in Billings and Laurel, account for about 90 percent of all oil refined in Montana.

Typical refinery products in Montana tend toward a larger proportion of heavy petroleum products (residual oils, asphalt, etc.) than a typical United States refinery. This is due to the characteristics of the crude oil feedstock.

Most petroleum products refined in Montana are exported. Residual fuel oils are marketed at mid-western industrial plants. Other refined products are transported to Eastern Washington, Wyoming, Utah, Colorado, Nebraska and the Dakotas.

Wood Products: The wood products industry is basic to a number of Western Montana communities and is significantly important to the entire mountainous portion of the state. Ranking as Montana's largest manufacturing industry, it has long been one of the state's basic industries. The primary energy consumer within this industrial sector is a Kraft pulp mill, located in Missoula. Other energy consumers within this sector are a particle board plant and a formaldehyde plant, also located in Missoula. The remaining components of the wood products industry are logging camps, sawmills, millwork plants, pole and post yards and plywood and venier plants.[11/] Several such plants utilize wood wastes as a major source of fuel for their processes; the nature of the Kraft process, however, requires additional energy input.

11/ Ibid.

The Kraft process accounts for the vast majority of wood pulp production in the United States. The process entails the introduction of wood chips (either in the form of wood wastes or processed roundwood) into digesters, where a cooking liquor is added. The resultant mix is cooked at 340° F. and at pressure (100 psig), during which time the lignin component is separated from the fibrous cellulose portion of the wood. After digestion, the cellulose is separated from the liquor, washed, dewatered and pressed into paper. The Kraft process is quite energy intensive. The Hoerner-Waldorf Plant in Missoula consumed 12.8 megawatts of electricity and 388,000 MCF of natural gas in 1973. In addition, large amounts of wood wastes also were used as fuel.[12/]

12/ Environmental Impact Statement for the Proposed Expansion of the Hoerner-Waldorf Pulp and Paper Mill at Missoula, Montana, Montana Department of Health and Environmental Sciences, November 1974.

CHAPTER II.

ENERGY AND THE MONTANA ECONOMY - FUTURE

Coal and Other Energy Forms

Many well-known economic and supply/demand factors have sharpened interest in all Montana energy sources. This section briefly describes geothermal and hydrothermal generation situations and presents data indicating exploration stage interest in oil and gas, uranium and coal. The section concludes with considerable detail about potential coal development, the most significant energy form in Montana's future.

Geothermal Energy

Areas of above-average earth heat flows, generally due to near surface circulation of hot water or the presence of abnormally hot rocks at modest depth have been known in Montana since the earliest exploration of the Yellowstone Park area. Hot springs are present in many areas of Western Montana.

The Montana Bureau of Mines and Geology, Butte, issued (Special Publication 65) a reconnaissance scale geothermal map of Central and Eastern Montana in September 1974. The map plots bottom hole temperatures and temperature gradients per 1,000 feet for all drill holes to the Madison limestone group for which data were available. The map shows several unsuspected temperature anomalies in North Central Montana. No detailed studies have been done in these

anomalous areas and prospects for future geothermal development are highly conjectural.

In 1973, with large-scale funding from the National Science Foundation, scientists from Battelle Northwest, Southern Methodist University and the University of Montana began detailed studies of a potential geothermal power site near Marysville. Shallow drill holes had found exceptionally high heat flows. Heat flow, seismic, electrical resistivity, gravity and magnetic surveys conducted in 1973 indicated the presence of a vast "hot-dry-rock" geothermal source. The high heat flows were believed attributable to a dry geologically recent granitic intrusion at depths between two and five kilometers.

A 1974 deep drill test, however, found great volumes of "warm" groundwaters at about 3,000 feet of depth. This unsuspected aquifer is believed to follow fracture zones in the host granitic rock and recharges rapidly with little drawdown after sustained pump tests. Most disappointing, however, is the fact that temperature gradients flattened markedly at depths below the initial water contact.

Much valuable information furthering general geothermal research has already been obtained at Marysville. The prospects for commercial power development at Marysville, however, seem much more remote than they appeared in early 1974. Some tests are continued and a detailed project status report will be issued by Battelle officials in December 1974.

Hydropower

As evidenced by Table I-11, almost 90 percent of Montana electrical generation is by hydroelectric means. According to the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers, many potential hydroelectric dam sites exist in Montana. MEAC is aware of no new major dam construction likely to be initiated within the next ten years. Construction of a major dam requires congressional authorization and long lead times for engineering feasibility and environmental impact studies. No such feasibility studies are now underway in Montana. None have been authorized by Congress.

A combination of factors discourage new hydroelectric projects in Montana. Most important is widespread public opposition to additional impoundments on Montana's remaining free flowing streams. Secondly, from an engineering viewpoint, the most amenable hydroelectric dam sites have already been utilized.

Bureau of Reclamation reconnaissance studies have treated a number of potential coal development-related storage facilities in Eastern Montana. Montana State Government feels, however, that the full impacts of mine site industrialization must be fully understood before commitments are made to supply water to the coal conversion industry.

Revised federal regulations on the interest rates at which federal dam projects must be amortized serve to increase long-term costs. According to Bureau of Reclamation officials, the increased interest

rates essentially preclude federal dams primarily devoted to providing irrigation water.

MEAC concludes that no new Montana hydroelectric dams are likely to be under construction in the next ten years. Near-term expansion of Montana's hydrogeneration capacity will therefore be limited to installation of turbines at the newly completed Libby Dam (Kootenai River) in Northwest Montana and possible expansion of peaking capacity at other existing reservoirs. Four new 121 megawatt turbine generators are scheduled to come on line at Libby Dam between July 1975 and April 1976. A fifth 121 megawatt unit is to be completed in October 1982.

Oil and Gas Exploration

As discussed in Chapter I of this report, significant production increases for crude oil and natural gas are largely dependent upon the discovery of new producing fields or new production zones within existing fields. Accordingly, specific projections of future production increases are difficult to make and are beyond the scope of this study.

However, exploration trends (petroleum drilling and leasing) can be compiled to document corporate interest in pursuing new discoveries. Table II-1 provides overview data regarding all oil and gas wells completed in Montana from 1958 through October 1974. The

table indicates a significant trend toward lower percentages of successful completion. The 1968-1969 peak in total wells completed is attibutable to drilling in and around the then newly producing Bell Creek Field (see Figures I-1 and I-2). Note that successful completions in 1968-1969 were predominantly oil wells.

Table II-1
Total Wells For Oil and Gas
State of Montana (1958 to 1974)

Year	Wells Completed	Oil	Gas	Dry Holes	Percent Dry Holes
1958	336	171	9	156	44.4
1959	325	157	13	155	47.7
1960	341	131	10	200	58.7
1961	397	164	8	225	56.7
1962	356	153	16	187	52.5
1963	371	144	12	215	58.0
1964	411	140	14	257	62.5
1965	499	189	13	297	59.5
1966	558	226	8	324	58.1
1967	542	197	34	311	57.4
1968	862	304	33	525	60.9
1969	878	181	50	647	73.7
1970	623	76	59	488	78.3
1971	462	62	48	352	76.2
1972	720	76	121	523	72.6
1973	693	63	126	504	72.7
1974 (thru Oct.)	516	48	111	357	69.2
Totals (15.8 years)	8,890	2,482	685	5,723	
Average	562	157	43	362	

Increased drilling in 1972-1973 is partially attributable to interest generated by the new Tiger Ridge gas field (Figure I-2). The Montana Oil and Gas Conservation Division also attributes post-1972 increased gas drilling to increases in natural gas prices.

The Department of State Lands administers and leases oil, gas and other minerals underlying approximately 5.5 million acres of state owned land. Table II-2 was compiled from the Department's biennial reports.

In that state lands are equally distributed (Sections 16 and 35 of most townships) over most of the state, interest in leasing state lands for petroleum should reflect leasing activity statewide.

Table II-2
Twenty-Year Summary of Oil and Gas
Leasing on Montana State Owned Lands

Fiscal Years	Leases Sold	Total Averages Leased (Acres)	Total Bonus Bids	Average Bid Per Acre
1955-56	513	323,227	$1,189,017	$5.12
1957-58	697	310,659	986,580	3.18
1959-60	676	263,185	697,589	2.65
1961-62	719	309,351	670,643	2.17
1963-64	905	407,375	995,118	2.44
1965-66	782	342,973	725,156	2.11
1967-68	1,849	918,602	5,718,536	6.23
1969-70	1,932	789,979	1,909,295	2.59
1971-72	1,456	646,955	1,069,429	1.72
1973-74	2,377	1,100,240	2,674,448	2.39

State petroleum lease sales are scheduled four times each fiscal year. Fixed lease rentals are charged. The leasing is competitive, however, with the successful bidder being determined by the amount of bonus bids offered for the first year's lease rental. The reader is cautioned that many state tracts have been repeatedly leased, let go, leased again, etc.

Increased leasing activity reported for Fiscal Years 1973 and 1974 is attributable to higher wellhead prices for "new" oil and to national interest in increasing domestic production. Thus, for both natural gas and petroleum, MEAC can report increased exploration activity.

Uranium

Montana uranium production has been small scale and intermittant. The state has no active uranium mines.

Uranium exploration, however, is underway in and around the Boulder batholith in several Western Montana counties. Tertiary age uranium deposits, associated with or perhaps included in Fort Union coal, are the target of significant exploration activity in extreme Southeastern Montana (Carter and Wibaux Counties).

Pursuant to the 1973 Montana Strip Mine Reclamation Act, an exploration permit is required before uranium or coal prospecting may proceed. Table II-3 provides summary data on the 90 prospecting permits issued by the Department of State Lands since June 1973. Twenty-eight permits have been issued for uranium prospecting, three for coal and uranium and 59 for coal.

Table II-3 Status of Prospecting Permits
Chapter 325, SLM, 1973

Company	Application Number	Date	Permit Number	Date Issued	Bond	Area To Be Disturbed (Acres) [1/]	Holes Drilled [2/]	County	Mineral	Status [3/]
Kerr-McGee	1	5/24/73	5	6/30/73 Reissued 10/1/73	40,000	30.0	333	Carter	Uranium	Expired 10/1/74
Peabody Coal	2	6/1/73	23	9/4/73 Reissued 10/29/73	164,500	154.5	1,228	Rosebud	Coal	Renewed 10/29/74
Peabody Coal	3	6/1/73	24	9/4/73 Reissued 10/29/73	63,300	53.3	0	Powder River	Coal	Renewed 10/29/74
Mobil Oil	4	6/8/73	3	6/21/73 Reissued 9/21/73	38,500	28.5	188	Carter	Uranium	Expired 9/21/73
Tenneco Coal	5	6/11/73	2	6/14/73 Inactive	20,000	7.9	44	Prairie	Coal	Expired 9/28/73
Tenneco Coal	6	6/11/73	1	6/14/73 Inactive	20,000	11.9	76	Dawson	Coal	Expired 9/28/73
Tenneco Coal	7	6/14/73	4	6/15/73 Inactive	27,700	27.7	75	Custer	Coal	Expired 9/28/73

1/ Area to be disturbed = number of holes x 1/10 acre per hole.
2/ Holes drilled -- compiled from monthly progress reports submitted through October 15, 1974.
3/ Status -- if blank, permit is active.

Table II-3 Cont'd.

Company	Application Number	Date	Permit Number	Date Issued	Bond	Area To Be Disturbed (Acres) [1]	Holes Drilled [2]	County	Mineral	Status [3]
Mobil Oil	8	6/21/73	8	6/30/73 Reissued 10/25/73	20,000	1.5	20	Wibaux	Coal Uranium	To Be Renewed-Inactive
Mobil Oil	9	6/21/73	7	6/30/73 Reissued 10/25/73	20,000	1.0	11	Fallon	Coal Uranium	To Be Renewed-Inactive
Mobil Oil	10	6/21/73	6	6/30/73 Reissued 10/25/73	20,000	13.5	99	Dawson	Coal Uranium	To Be Renewed-Inactive
Felmont Oil	11	6/22/73	15	8/6/73 Reissued 9/21/73	77,500	63.5	429	Carter	Uranium	Renewed 9/21/74
Sun Oil	12	7/2/73	9	7/16/73 Reissued 9/21/73	17,100	7.1	54	Powder River	Coal	Expired 9/21/74
Mobil Oil	13	7/9/73	12	7/30/73 Reissued 9/27/73	20,000	3.4	26	Mussel-shell	Uranium	To Be Renewed-Inactive
Mobil Oil	14	7/9/73	11	7/26/73 Reissued 10/2/73	20,000	2.4	14	Yellow-stone	Uranium	Renewed 11/1/74
Utah International	15	7/12/73	14	7/31/73 Inactive	20,000	1.0	12	Custer	Coal	Expired 9/28/73
Teton Exploration	16	7/13/73	16	8/6/73 Inactive	20,000	3.0	25	Fallon	Uranium	Expired 9/28/73
American Nuclear	17	7/18/73	13	7/31/73 Inactive	13,300	4.5	26	Carter	Uranium	Expired 9/28/73

Table II-3 Cont'd.

Company	Application Number	Date	Permit Number	Date Issued	Bond	Area To Be Disturbed (Acres) [1/]	Holes Drilled [2/]	County	Mineral	Status [3/]
Decker Coal	18	7/18/73	10	7/23/73 Reissued 9/21/73	150,000	140.0	718	Big Horn	Coal	Renewed 9/21/74
Tenneco	19	7/18/73	20	8/10/73 Reissued 9/26/73	24,100	14.1	76	Richland	Coal	Expired 9/26/74
Tenneco	20	8/1/73	17	8/6/73 Inactive	20,000	10.8	87	Fallon	Coal	Expired 9/28/73
Tenneco	21	8/1/73	18	8/6/73 Inactive	20,000	2.4	16	Carter	Coal	Expired 9/28/73
Tenneco	22	8/1/73	22	8/23/73 Reissued 9/27/73	20,000	6.3	14	Rosebud	Coal	Expired 9/27/74
Mobil	23	8/2/73	21	8/13/73 Reissued 9/21/73	20,000	6.0	44	Garfield	Uranium	Expired 9/21/74
Western Energy	24	8/8/73	19	8/9/73 Reissued 9/27/73	100,000	90.0	854	Rosebud	Coal	Renewed 9/27/74
Mobil Oil	25	8/8/73	27	10/2/73	20,000	0.7	5	Golden Valley	Uranium	Renewed 11/1/74
Western Nuclear	26	8/20/73	33	10/9/73	20,000	0.5	5	Carbon	Uranium	Expired 10/9/74

Table II-3 Cont'd.

Company	Application Number	Date	Permit Number	Date Issued	Bond	Area To Be Disturbed (Acres) [1/]	Holes Drilled [2/]	County	Mineral	Status [3/]
Montana Nuclear	27	8/27/73	Never Issued - No Bond Submitted				0	Carter	Uranium	Not Issued
Wold, John S.	28	8/30/73	34	10/25/73	20,000	4.5	15	Wibaux	Coal	Expired 10/25/74
Mobil Oil	29	9/4/73	32	10/17/73	22,000	0.3	1	Petroleum	Uranium	Renewed 11/1/74
Mobil Oil	30	9/4/73	31	10/17/73	76,000	2.8	9	Judith Basin	Uranium	Renewed 11/1/74
Mobil Oil	31	9/4/73	30	10/17/73	56,000	4.3	19	Fergus	Uranium	Renewed 11/1/74
Tenneco	32	9/4/73	25	9/26/73	30,700	20.7	110	Wibaux	Coal	Renewed 9/26/74
Westmoreland Resources	33	9/28/73	26	9/28/73	16,900	6.9	64	Big Horn	Coal	Expired 9/28/74
Tenneco	34	9/18/73	39	10/31/73	17,400	7.4	55	McCone	Coal	Expired 10/31/74
Tenneco	35	9/18/73	40	10/31/73	12,400	2.4	26	Garfield	Coal	Expired 10/31/74
Tenneco	36	9/18/73	29	10/15/73	15,000	5.0	13	Roosevelt	Coal	Expired 10/15/74
Tenneco	37	9/18/73	28	10/15/73	14,500	4.5	35	Sheridan	Coal	Expired 10/15/74
Burlington Northern	38	10/10/73	46	12/12/73	20,000	1.6	14	Fallon	Coal	

Table II-3 Cont'd.

Company	Application Number	Date	Permit Number	Date Issued	Bond	Area To Be Disturbed(Acres) [1/]	Holes Drilled [2/]	County	Mineral	Status
Continental Oil	39	10/17/73	38	10/30/73	10,400	.3	3	Powell	Uranium	Expired 10/30/74
Continental Oil	40	10/17/73	37	10/30/73	11,300	.8	8	Gallatin	Uranium	Expired 10/30/74
Consolidation Coal	41	10/24/73	44	11/26/73	14,300	4.3	12	Prairie	Coal	
Consolidation Coal	42	10/24/73	43	11/26/73	43,500	33.0	103	Custer	Coal	
Continental Oil	43	10/17/73	35	10/30/73	10,800	1.0	8	Broad-water	Uranium	Expired 10/30/74
Continental Oil	44	10/17/73	36	10/30/73	10,600	1.0	2	Deer Lodge	Uranium	Expired 10/30/74
Continental Oil	45	10/31/73	41	11/5/73	11,500	1.1	11	Sweet Grass	Uranium	
Mobil Oil	46	11/19/74	50	1/7/74	17,000	4.0	14	Richland	Coal	
Wold, John S.	47	11/19/73	42	11/20/73	20,000	0.7	3	Roosevelt	Coal	
Mobil Oil	48	11/26/73	45	12/12/73	13,000	2.8	9	McCone	Coal	
Phillips	49	12/11/73	53	1/16/74	10,800	0.8	4	Dawson	Coal	
Phillips	50	12/11/73	51	1/16/74	14,700	4.7	14	Custer	Coal	

Table II-3 Cont'd.

Company	Application Number	Date	Permit Number	Date Issued	Bond	Area To Be Disturbed (Acres) [1/]	Holes Drilled [2/]	County	Mineral	Status
Phillips	51	12/11/73	52	1/16/74	12,000	2.0	13	Prairie	Coal	
Tenneco	52	12/12/73	47	12/17/73	18,800	4.5	40	Fallon	Coal	
Tenneco	53	12/13/73	48	12/18/73	18,100	3.1	25	Dawson	Coal	
American Nuclear	54	12/17/73	49	12/18/73	see 13	0.7	7	Carter	Uranium	
Burlington Northern	55	1/3/74	56	2/4/74	15,000	3.5	37	McCone	Coal	
Western Energy	56	1/3/74	60	2/25/74	22,000	12.0	43	Custer	Coal	
Western Energy	57	1/3/74	54	1/18/74	45,000	35.0	167	Fallon	Coal	
Western Energy	58	1/3/74	55	1/21/74	14,000	4.0	13	Carter	Coal	
McCartney, Clay H.	59	1/17/74	57	2/11/74	25,000	15.0	101	Blaine	Coal	
Mobil Oil	60	1/24/74			20,000	10.0	0	Rosebud	Coal	Not Issued
Consolidation Coal	61	2/15/74	58	2/19/74	33,000	21.4	0	Treasure	Coal	
Consolidation Coal	62	2/15/74	59	2/19/74	32,700	21.4	59	Big Horn	Coal	
Consolidation Coal	63	3/18/74	64	6/24/74	48,100	38.1	171	Rosebud	Coal	
Getty Oil	64	4/26/74	82	9/19/74	15,000	4.6	0	Dawson	Coal	
Getty Oil	65	4/26/74	79	9/13/74	12,000	2.0	0	Richland	Coal	
McCartney, Clay H.	66	4/30/74	62	5/28/74	15,000	3.0	0	Hill	Coal	

Table II-3 Cont'd.

Company	Application Number	Date	Permit Number	Date Issued	Bond	Area To Be Disturbed (Acres) [1/]	Holes Drilled [2/]	County	Mineral	Status
Amax Coal	67	5/2/74	74088	10/7/74	11,900	1.9	0	Powder River	Coal	
Concho Petroleum	68	5/7/74	61	5/10/74	10,300	0.3	3	Big Horn	Coal	
Utah International	69	5/15/74	71	7/22/74	13,000	2.3	18	Madison	Uranium	
Continental Oil	70	5/28/74	65	7/2/74	0	0	0	Jefferson	Uranium	Inactive
Continental Oil	71	5/28/74	66	7/2/74	0	0	0	Madison	Uranium	Inactive
Chevron Oil	72	5/30/74	63	6/13/74	15,000	3.0	11	Garfield	Coal	
Gulf Mineral	73	6/11/74	67	7/2/74	20,900	10.9	73	Custer	Coal	
Gulf Mineral	74	6/13/74	68	7/2/74	18,800	8.8	65	Powder River	Coal	
Exxon	75	6/13/74	69	7/10/74	10,300	0.3	0	Silver Bow	Uranium	
Exxon	76	7/1/74	72	7/24/74	31,300	21.3	45	Carter	Uranium	
Knife River Coal	77	7/2/74	70	7/15/74	10,600	0.6	0	Richland	Coal	
Wold, John	78	7/5/74	75	8/6/74	20,000	1.2	13	Dawson	Coal	
Sun Oil	79	7/5/74	73	7/25/74	12,000	2.0	0	Richland	Coal	
Sun Oil	80	7/5/74	74	7/25/74	18,900	9.0	70	Dawson	Coal	
Consol	81	7/17/74	84	10/1/74	15,000	5.0	0	Powder River	Coal	
Mobil	82	7/26/74	77	9/4/74	11,200	1.2	0	Powder River	Coal Uranium	

Table II-3 Cont'd.

Company	Application Number	Date	Permit Number	Date Issued	Bond	Area To Be Disturbed (Acres) [1/]	Holes Drilled [2/]	County	Mineral	Status
N.R.G.	83	8/1/74	80	9/11/74	12,300	2.3	0	Big Horn	Coal Uranium	
Utah International	84	8/5/74	81	9/11/74	15,000	3.3	2	Cascade	Uranium	
Crisafulli	85	8/2/74	76	8/27/74	11,900	1.9	19	Dawson	Coal	
N.R.G.	86	8/16/74	78	9/6/74	12,500	2.5	0	Powder River	Coal Uranium	
Utah International	87	9/3/74	85	10/4/74	18,000	8.0	0	Garfield	Coal	
Utah International	88	9/3/74	86	10/4/74	15,000	4.3	0	Prairie	Coal	
Utah International	89	9/3/74	87	10/4/74	13,000	2.9	0	McCone	Coal	
Agri-Empire, Inc.	90	10/15/74			12,100	2.1		Prairie	Coal	Not Issued

Note: Total Bond on File $2,179,500
Total Holes Permitted 10,758
Total Holes Drilled 6,026
Data current as of October 15, 1974.

Coal

Unlike all other conventional energy sources in Montana, coal reserves virtually pose no limits on future coal-related energy development. (As discussed in following sections of this report, socio-economic considerations and water availability are major constraints.) Table II-4 provides coal reserve, tons per acre and coal quality data for 62 Eastern Montana coal fields. As new information from current drilling programs becomes available, the total of 42.6 billion tons of strippable reserves will surely be increased. Figure II-1[13/] locates the coal deposits listed in Table II-4.

Coal Leasing: As evidenced by Table II-3, these vast reserves are being actively explored. Coal leasing data also document great corporate interest in developing the Fort Union coal deposits of Eastern Montana. According to the Northern Great Plains Resource Program,[14/] approximately 36,000 acres of federal coal, 58,000 acres of state coal and 77,000 acres of Indian owned coal have been leased in Montana.

13/ Matson, Robert E., Montana Bureau of Mines and Geology, unpublished open file report, 1974.
14/ NGPRP Draft Interim Report, September 1974, page 6.

Table II-4

MONTANA BUREAU OF MINES AND GEOLOGY

Strippable subbituminous and lignite coal fields, eastern Montana

No. on map	Name of field	Coal bed	Est. reserves in millions of tons	Acreage	Average tons/acre	Ash[1]	Sulfur[1]	Btu[1]
1	Decker	Anderson-Dietz 1&2	2,239.99	25,523	87,763	4.0	.40	9,652
2	Deer Creek	Anderson-Dietz 1&2	495.65	14,214	35,397	4.0	.50	9,282
3	Roland	Roland	218.04	12,076	18,055	9.2	.74	8,164
4	Squirrel	Roland	133.41	6,208	21,490	5.5	.29	7,723
5	Kirby	Anderson	216.52	5,655	38,285	4.2	.32	8,328
		Wall	473.69	5,952	79,579			
		Dietz	834.35	17,516	47,630	5.8	.59	8,509
		Canyon	158.53	4,066	38,983	5.8	.24	8,789
6	Canyon	Wall	1,884.25	23,859	78,974	4.6	.30	9,088
		Brewster-Arnold	65.86	2,067	31,859	7.5	.40	8,444
7	Birney	Brewster-Arnold	180.55	6,969	25,905	5.1	.41	9,055
8	Poker Jim Lookout	Anderson-Dietz	872.65	19,609	44,501	5.2	.37	7,925
9	Hanging Woman Cr.	Anderson	1,583.29	30,547	51,830	4.9	.29	8,496
		Dietz	1,120.96	43,654	25,678	5.5	.33	8,078
10	West Moorhead	Anderson	883.74	19,660	44,949	5.3	.36	8,296
		Dietz	397.49	20,416	19,469	4.1	.41	7,990
		Canyon	690.19	22,547	30,611	5.6	.45	8,055
11	Poker Jim O'Dell	Knobloch	373.29	7,890	47,311	5.1	.22	8,846
		Knobloch	564.78	7,187	78,581			
12	Otter Creek	Knobloch	2,075.55	25,791	80,475	4.7	.36	8,468
13	Ashland	Knobloch	2,696.20	27,200	99,125	4.8	.15	8,421
		Sawyer A & C	357.49	20,262	17,643	4.9	.49	7,883
14	Colstrip	Rosebud	1,439.26	33,379	43,118	9.5	.12	8,836
15	Pumpkin Creek	Sawyer	2,426.50	45,695	53,102	7.5	.34	7,438
16	Foster Creek	Knobloch	708.13	27,801	25,470	7.8	.76	7,573
		Terret	460.87	27,462	16,782	5.8	.21	7,770
		Flowers-Goodale	258.90	14,444	17,924	7.8	.51	7,553
17	Broadus	Broadus	739.82	18,429	40,142	7.2	.27	7,437
18	East Moorhead	T	525.21	15,559	33,756	6.2	.57	7,120
19	Diamond Butte	Canyon	418.02	21,363	19,566	4.8	.43	7,330
20	Goodspeed Butte	Cook	628.95	13,446	46,775	10.6	1.63	6,771
21	Fire Gulch	Pawnee & Cook	336.69	8,486	39,674	3.8	.33	7,739
22	Sweeney-Snyder	Terret	326.33	10,921	29,880	9.1	.11	8,175
23	Yager Butte	Elk & Dunning	1,175.86	26,924	43,673	4.8	.33	7,646
		Cook	312.02	14,507	21,507	6.7	.63	7,254
24	Threemile Buttes	Canyon & Ferry	225.40	13,836	16,289	5.5	.94	6,867
25	Sonnette	Pawnee	320.25	8,224	38,940	9.8	.88	6,964
		Cook	362.98	10,470	34,668	8.1	1.23	6,891
26	Home Creek Butte	Canyon & Ferry	217.21	4,851	44,774			
27	Little Pumpkin Creek	Sawyer A&C, D, X, & E	215.83	8,534	25,290			
28	Sand Creek	Knobloch	267.34	5,952	44,915	6.6	.30	7,340
29	Beaver-Liscom	Flowers-Goodale & Terret	135.87	8,851	15,350	8.1	.96	8,102
		Knobloch	491.62	17,075	28,791	7.7	.50	8,027
30	Greenleaf-Miller Creek	Rosebud, Knobloch, and Sawyer	453.71	14,918	30,413	7.5	.71	8,422
31	Pine Hills	Dominy	193.87	6,022	32,191	7.2	.53	7,293
32	Knowlton	Dominy (M & L)	747.51	19,613	38,112	7.1	.41	6,710
		Dominy (U)	120.31	4,448	27,048	5.6	.38	6,645
33	Sarpy Creek	Rosebud-McKay	1,500.00	42,373	35,400	6.5	.50	8,600
34	Cheyenne Meadows	Knobloch	1,200.00	13,560	88,500	4.1	.40	8,400
35	Little Wolf	Rosebud-McKay	314.00	7,411	42,370			
36	Jeans Fork		90.00	3,800	23,685			
37	Wolf Mountains		1,922.00	31,000	62,000			
38	Lame Jones	Dominy	150.00	10,593	14,160			6,020
39	Lamesteer	Harmon(?)	35.00	1,978	17,700			6,332
40	Wibaux	C	643.00	18,518	34,720	7.9	.90	6,050
41	Little Beaver	C	134.00	8,445	15,865			
42	Four Buttes	C	91.00	5,180	17,570			6,140
43	Hodges		10.00	807	12,390			
44	Griffith Creek		10.00	568	17,700			

Table II-4 Cont'd.

MONTANA BUREAU OF MINES AND GEOLOGY

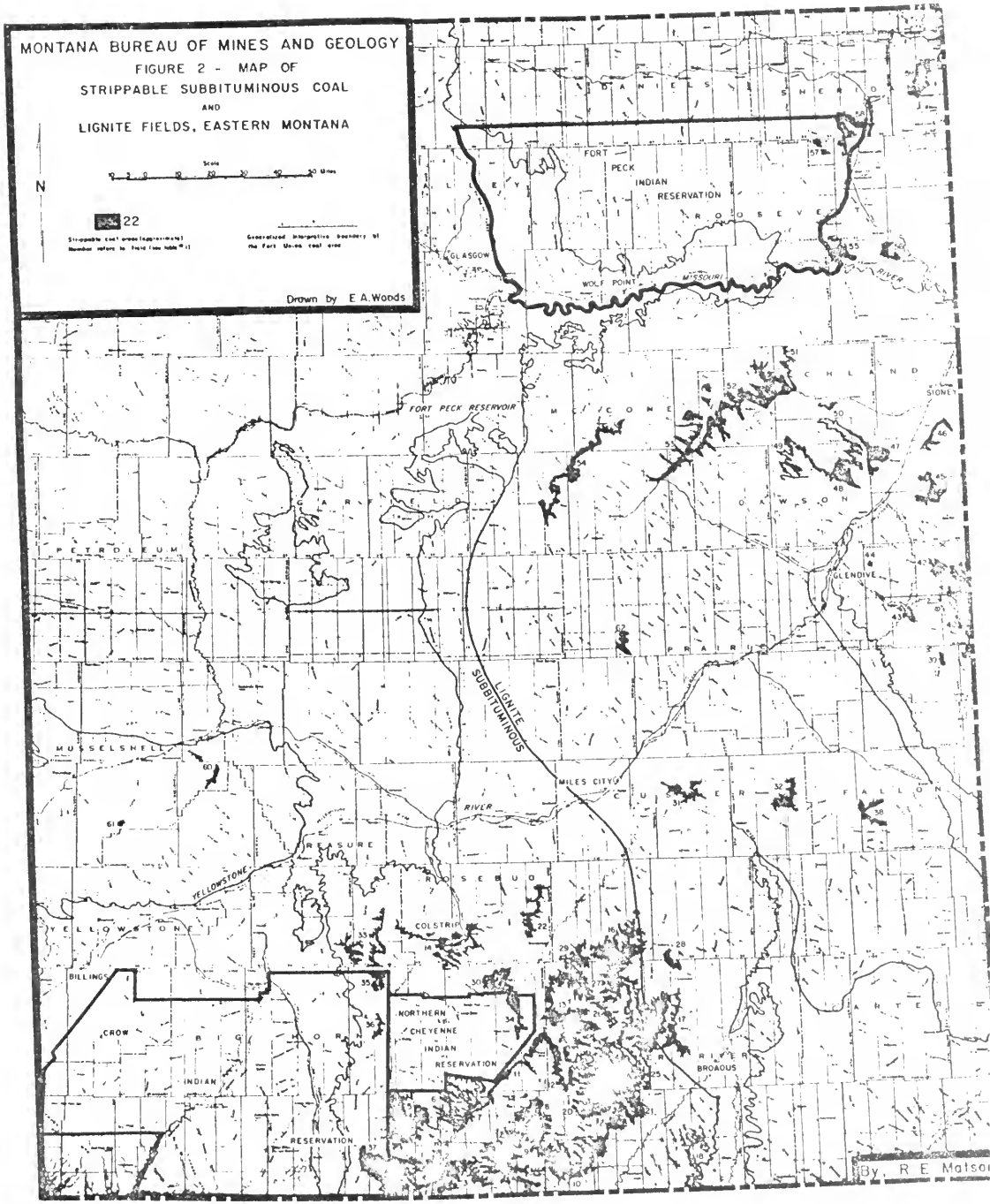
Strippable subbituminous and lignite coal fields, eastern Montana

No. on map	Name of field	Coal bed	Est. reserves in millions of tons	Acreage	Average tons/acre	Ash[1]	Sulfur[1]	Btu[1]
45	Smith-Dry Creek	G	150.00	8,475	17,700			
46	O'Brian-Alkalie Creek		150.00	8,475	17,700			
47	Breezy Flat	Pust	200.00	7,062	30,090	6.7	.50	6,660
48	Burns Creek	Pust	200.00	7,062	30,090			
49	N.F.Thirteen Mile Creek	Pust	225.00	5,085	44,250			6,880
50	Fox Lake	Pust	46.00	2,166	21,240			6,880
51	Lane	Lane	561.00	44,582	12,390			7,150
52	Carroll	Carroll	345.00	29,780	11,584	5.5	.30	7,400
53	Redwater River	S	642.00	24,181	26,550	6.1	.40	7,400
54	Weldon-Timber Creek	S	724.00	25,565	28,320			7,660
55	Fort Kipp	Ft. Kipp-Ft. Peck	331.00	14,500	22,830	4.6	.20	6,110
56	Lanark	Lanark	100.00	3,531	12,390	6.3	.40	6,853
57	Medicine Lake		58.00	3,740	15,510	7.2	1.00	6,870
58	Reserve		246.00	18,231	13,495	7.6	.40	6,599
59	Coal Ridge	Coal Ridge	150.00	19,200	17,700	7.5	.40	5,830
60	Carpenter Creek	Carpenter	50.00	3,211	14,015	6.5	.40	9,270
61	Charter	Mammoth	60.00	3,210	17,700	6.0	.90	10,190
62	Little Sheep Mtn.	A&C	200.00	10,272	19,470			
		TOTAL	42,561.93	1,152,640				

[1]"As received" basis (where more than one sample available, figures given are average figures).

By Robert E. Matson

Figure II-1


MONTANA BUREAU OF MINES AND GEOLOGY
FIGURE 2 - MAP OF
STRIPPABLE SUBBITUMINOUS COAL
AND
LIGNITE FIELDS, EASTERN MONTANA
N
Scale
22
Drawn by E.A.Woods
FORT PECK INDIAN RESERVATION
GLASGOW
WOLF POINT
MISSOURI RIVER
FORT PECK RESERVOIR
LIGNITE SUBBITUMINOUS
MILES CITY
YELLOWSTONE RIVER
COLSTRIP
BILLINGS
CROW INDIAN RESERVATION
NORTHERN CHEYENNE INDIAN RESERVATION
BROADUS
GLENDIVE
PETROLEUM
MUSSELSHELL
TREASURE
ROSEBUD
CARTER
DAWSON
PRAIRIE
FALLON
By, R E Matso

In reflecting to public concern about cumulative impacts of coal development, the last state coal lease sale was held in May 1970. A defacto federal coal leasing moratorium is still in effect with new federal leases limited to those necessary for continuation of existing strip mining operations. Both the Northern Cheyenne and Crow Tribes have petitioned the Secretary of the Interior for cancellation of existing Indian coal leases. Hence, the status of the 77,000 acres of Indian coal leased is in doubt.

Given the constraints on aquisition of rights to public-owned coal, it is not surprising that explosive lease, option and surface rights aquisition activity has taken place on privately-owned surface and mineral estates in Eastern Montana.

Most significant are the lease and lease option data recently compiled for 12 Eastern Montana counties by Action for Eastern Montana. 15/ The county-by-county summaries presented in Table II-5 indicate that energy corporations and lease brokers have obtained interest in over 1,000,000 acres. The interests are primarily in the form of leases of surface and/or coal holdings, options to lease and mining leases which essentially convey the rights to strip mine. Similar data are being prepared for other counties by the Billings-based Northern Plains Resource Council.

15/ Action for Eastern Montana is a non-profit, Glendive-based corporation primarily funded by the federal government. Its major function is to analyze the needs of 17 Eastern Montana counties in terms of education, transportation, housing, aging, health and medical service. The corporation undertook the coal and surface lease inventory because coal development may greatly influence future levels of services needed. For certain counties, coal, bentonite and uranium lease data were not separated.

The first date appearing beneath each county name marks the date of the first recorded lease or option. The second date records last filing noted by the survey.

Table II-5
Action for Eastern Montana
Data on Coal and Surface Leases, Etc.

Carter County (Jan. '66 - May '74)
Coal, Uranium and Bentonite Activity

	Acres
Mining Leases	92,464
Mining Claims	143,495
Surface Agreements	6,729
Exploration With Option to Lease	9,160
Grand Total	251,848

All listed mining claims are not coal related, but are for bentonite or uranium. The mining leases can be for coal, uranium or bentonite. (The contracts did not specify.)

Custer County (May '70 - July '74)

Coal Leases	27,544
Surface Agreements	3,468
Exploration and Option for Coal Lease	115,080
Grand Total	146,092

Table II-5 Cont'd.

	Acres
Dawson County (July '70 - June '74)	
Coal Leases	102,645
Surface Agreements	42,412
Mining Leases	7,204
Oil, Gas and Mineral Leases	2,080
Grand Total	154,341
Fallon County (Sept. '72 - July '74)	
Abstract of Option for Coal Lease	135,758
Coal Leases	15,877
Surface Agreements	7,525
Abstract of Instrument Coal Lease - Surface Agreement	20,850
Grand Total	180,010
Garfield County (Dec. '68 - May '74)	
Coal, Uranium and Mineral Lease	20,131
Mining Claims	1,040
Royalty Conveyance	580
Mineral Deeds	8,960
Grand Total	30,711
McCone County (May '72 - May '74)	
Coal Leases	60,482
Surface Agreements	38,950
Mining Leases	8,153
Grand Total	107,585
Powder River (Oct. '66 - May '74)	
Coal Leases	87,168
Surface Agreements	24,720
Exploration with Option to Coal Lease	35,580
Oil, Gas and Mineral Lease	880
Grand Total	148,348

Table II-5 Cont'd.

	Acres
Prairie County (Dec. '72 - Feb. '73)	
Exploration with Option to Acquire Coal Lease (Must be exercised by Dec. 2, 1974.)	7,380
Coal Lease	640
Grand Total	8,020
Richland County (May '72 - April '74)	
Coal Leases	21,492
Surface Agreements	12,980
Options of Coal Lease	2,560
Grand Total	37,032
Rosebud County (June '59 - July '74)	
Coal Leases	43,654
Surface Agreements	12,887
Mining Leases	28,760
Options for Coal Lease	15,515
Options for Surface Lease	6,785
Deeds, Indentures, Contracts (coal related)	16,720
Grand Total	124,321
Treasure County (Oct. '67 - June '73)	
Exploration and Option for Coal Lease	9,680
Coal Leases	4,480
Surface Agreements	7,420
Combination Leases	6,100
Bentonite Leases	3,840
Grand Total	31,520

Table II-5 Cont'd.

	Acres
Wibaux County (Mar. '72 - Mar. '74)	
Coal Leases	16,391
Surface Agreements	37,169
Mining Leases	32,257
Grand Total	85,817

Excluding the mining claims in Carter County, a total of 1,162,150 acres have been obligated in some manner. Excluding all Carter County data, over one million acres are involved in 11 counties.

Projected Coal Production: Table II-6 on the following page conveys MEAC's conservative estimate of Montana coal production for years 1974 through 1980. Except as footnotes indicate, it is based on existing coal sales contracts. Table II-6 was compiled in late October 1974 and arbitrarily assumes, for purposes of calculation, that the future operations will meet the requirements of the Montana Strip Mine Siting, Mine Reclamation, Coal Conservation and Utility Siting Acts. Those future decisions will, of course, be determined by the regulatory agencies and boards, with full public involvement.

Table II-6 Projected Montana Coal Production
From Coal Sales Contracts, By Year
(Data Gathered October 14 - 18, 1974 by MEAC Staff)

		1974	1975	1976	1977	1978	1979	1980
Peabody	1/	2,700,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Western Energy	2/	2,837,000	5,230,000	10,430,000	13,500,000	14,900,000	17,700,000	19,100,000
Knife River	3/	320,000	320,000	320,000	320,000	320,000	320,000	320,000
Decker	4/	7,000,000	8,250,000	10,900,000	10,900,000	14,500,000	12,100,000	13,900,000
Westmoreland	5/	1,500,000	4,000,000	4,000,000	6,500,000	6,500,000	6,500,000	6,500,000
Totals		14,357,000	20,800,000	28,650,000	34,220,000	39,220,000	39,620,000	42,820,000

1/ The Peabody figures are estimates obtained from corporate headquarters, St. Louis, Missouri. Another major sales contract for their Big Sky Mine near Colstrip is presently being negotiated.

2/ Projections for Western Energy's Big Sky Mine at Colstrip include coal consumed at Colstrip Units I and II for 1975 and beyond. For 1978 - 1980, they include coal that would be furnished to Colstrip Units III and IV. If Units III and IV are not approved by the State of Montana, a projected 13,500,000 tons would be mined each year. Yearly totals would drop accordingly.

3/ Knife River Coal's mine at Savage, Montana, produces lignite exclusively for the 50 megawatt Lewis and Clark steam plant near Sidney. The mine's annual production for the last eight years averaged just over 321,000 tons.

4/ Projected production for the Decker Coal Mine north of the Town of Decker drops from 1978 to 1979, reflecting a short-term contract that expires in 1978. It is very likely that future coal sales contracts will bring 1979 and 1980 projections to 1978 levels.

5/ Westmoreland Resources has not yet negotiated a contract or contracts that would boost projections for its Sarpy Creek Mine to 6,500,000 tons in 1977. The company recently provided two unit train test shipments to domestic utilities, and MEAC believes that coal sales at the elevated level can be almost definitely anticipated.

In addition to the production projected in Table II-6 on the preceeding page, it is possible that some of the companies now conducting detailed exploration may be in a position to open new mining operations by late 1979 or 1980. Further, the Shell Oil Company has announced plans to open a two million ton per year strip mine in 1978 on the Crow Indian Reservation. Shell expects to expand production to eight million tons per year in 1980.

Table II-7 breaks down the 1975 and 1980 projections by coal use. Clearly, almost all Montana coal produced through 1980 will be consumed in steam-fired electrical generation plants. Most of this utility coal will be burned in the Midwestern United States.

Table II-7: 1975 and 1980 Coal Production
By Coal Use (Millions of Tons)

1975 Electrical Generation in Montana		Coal for Export	
0.32	Knife River for Sidney Plant	4.33	Western Energy Co.
0.50	Western Energy for Corette Plant - Billings	8.25	Decker Coal Co.
		4.00	Westmoreland
0.40	Western Energy for Colstrip I (coming on line)	3.00	Peabody
1.22	million tons	19.58	million tons
1980			
0.32	Knife River Coal Co.	10.00	Western Energy (min.)
0.50	Corette Plant	13.90	Decker Coal
3.00	Colstrip I and II (Western Energy)	3.00	Peabody
5.60	Colstrip III and IV (Western Energy)	6.50	Westmoreland
9.42	million tons	33.40	million tons

Critical Factors in Industry Siting

In the furor over existing and impending coal development, communication with industrial concerns regarding critical variables in the siting of energy-related facilities has been far from satisfactory. Conflicting opinions posed by various interests often have been the only sources of such information. Awareness of critical siting variables is essential to government and legislative bodies charged with the responsibility of regulating and responding to industrial development. Such information also would be of use to citizen groups concerned with industrial development. The Montana Energy Advisory Council, in cooperation with the Northern Great Plains Resource Program, has attempted to determine what variables may be of prime concern to energy interests facing siting decisions.

Method

In initiation of the project, a list of possible variables pertinent to the siting of strip coal mines and energy conversion facilities was developed. Some of the variables listed were taken from rumored elements of importance; others were developed in consultation with an economist. These variables then were arranged on a survey form in conjunction with instructions to rank them in descending order of importance. The items developed for mining were different, to some degree, from those developed for energy conversion firms. The items listed were as follows:

Energy Conversion Facilities

Forms 1 and 2

- proximity to market
- transportation cost and availability
- coal requirements (quality and quantity)
- water requirements
- labor availability
- availability of community services
- siting requirements
- environmental laws (air quality, reclamation, etc.)
- existence of transmission corridors, pipelines
- tax structure (coal and corporate taxes)
- supply of construction, operation materials
- land requirements
- community or regional acceptance of a proposed project

Form 3

- community acceptance of the plant (at mine mouth and load center)
- transportation availability and cost
- environmental laws (at both locations)
- siting laws (at both locations)
- water availability (at both locations)
- labor availability
- availability of community services (both during construction and during operations)

Strip Coal Mines

Forms 1 and 2

- proximity to market
- transportation cost and availability
- quantity of coal
- quality of coal (BTU rating, sulfur content, etc.)
- overburden characteristics
- tax structure (corporate taxes, coal taxes)
- reclamation laws
- possibility of future mine-mouth energy conversion
- availability of leases (mineral rights)
- public opinion

Differences between Forms 1 and 2 of both the mining and energy company surveys were limited to the implied specificity of the industrial site. On Form 1, the site was defined as the Northern Great Plains Region. On Form 2, the site was defined as any specific locus within the Northern Great Plains area. The third form, for energy conversion companies, was developed in order to begin to isolate those variables that determine whether a conversion facility will be located at the load center or at the mine mouth.

The completed forms were sent to the Program Manager of the NGPRP, who had prepared a list of some 79 energy companies. The forms were distributed to those companies, with a cover letter of explanation, by the NGPRP.

The Montana Energy Advisory Council agreed to process whatever data was received in the course of the project, and to prepare a brief summary report. Due to the ordinal nature of the data that was to result from the project and to the selective and limited nature of the likely project sample, a nonparametric test of statistical inference was selected. The use of parametric tests of statistical inference was ruled out because the assumptions underlying their appropriate use could not be met. The test chosen to examine the data for significance was the Kolmogonov-Smirnov One-Sample Test, a very powerful test of significance.[16/]

In the event that responses received from energy conversion interests permitted intergroup comparisons, the Kruskal-Wallis One-Way Analysis of Variance was chosen as the appropriate test. The Kruskal-Wallis test permits the testing of the null hypothesis that two observed groups come from the same population.[17/]

Examples of the survey forms developed for the project are attached in Appendix A. Lists of the industrial firms contacted and those responding to the survey are presented in Appendix B.

Results

Response to the survey was disappointing. Of the forms distributed, only 16 responses were received from energy conversion

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16/ Non-parametric Statistics for the Behavioral Sciences, Sidney Liegel, McGraw-Hill, New York 1956, pp. 47-52.
17/ Ibid., pp. 184-193.

interests; 15 responses were received from the coal companies surveyed.

Raw data from the completed surveys were transferred to data summary sheets for statistical analysis. Modal ranks were determined for each item.

The summarized data were analyzed using the Kolmogonov-Smirnov One-Sample Test, a test of goodness of fit. In performing this test, the observed frequency distribution of responses is compared to a specified theoretical distribution of responses. If the frequency distribution of ranks assigned each siting variable is controlled by chance, each rank assigned a particular item would have an equal probability of occurrence. The theoretical distribution derived in this project was based upon this assumption -- i.e., that the cumulative frequency distribution of ranks would assume the same form as the cumulative distribution of equally likely events.

In analysis, a cumulative distribution of observed response frequencies was computed for each siting variable, and compared to the corresponding theoretical cumulative frequency distribution. Differences between the theoretical and observed distributions were recorded.

The 0.10 level of significance was chosen for this analysis, due to the preliminary nature of the project. Statistically significant results were as follows:

In Table II-8 are presented summary statistics for each siting variable of Form 1 of the energy company survey, for which statistical significance was found. Listed are the identity, the modal rank and the level of chance probability of occurrence associated with the difference noted between the theoretical and observed distributions. Note that of the 13 items listed in the form, only four were found to be statistically significant.

Table II-8: Identity, Modal Rank and Chance Probability of Occurrence for Significant Items - Form EC-1

	Item	Modal Rank	Probability
3:	Coal Requirements	1	Less than 0.01
4:	Water Requirements	2	Less than 0.01
6:	Availability of Community Services	11	0.10 greater than p greater than 0.05
11:	Supply of Construction, Operation Materials	13	Less than 0.01

*/ No separate analysis was performed for this item because the modal response, a rank of 1, accounted for all but one of the responses tallied. Probability was assigned by inference in comparison to Item 4.

Summary statistics for each statistically significant siting variable of Form 2 of the Energy Company Survey are presented in Table II-9. Listed are the identity, the modal rank and the level of chance probability of occurrence associated with the difference

noted between the theoretical and observed distributions. Of the 13 items listed in the form, six were found statistically significant.

Table II-9: Identity, Modal Rank and Chance Probability Occurrence for Significant Items - Form EC-2

Item	Modal Rank	Probability
3: Coal Requirements (Quantity and Quality)	1	Less than 0.01 */
4: Water Requirements	2	Less than 0.01
5: Labor Availability	11	0.10 greater than p greater than 0.05
7: Siting Regulations	5	0.10 greater than p greater than 0.05 */
8: Environmental Laws (Air Quality, Reclamation, Etc.)	6	Less than 0.01
11: Supply of Construction, Operation Materials	10	Less than 0.01

*/ Modal response accounted for all but one response. Hence, a separate analysis was not conducted. Probability was assigned by inference in comparison to Item 4.

Presented in Table II-10 are summary statistics for each statistically significant siting variable presented in Form 3 of the energy company survey. Listed are the identity, the modal rank and the level of chance probability of occurrence associated with the difference noted between distributions. Of the seven items listed on Form 3, four were found to be statistically significant.

Table II-10: Identity, Modal Rank and Chance Probability of Occurrence for Significant Items - Form EC-3

	Item	Modal Rank	Probability
4:	Siting Laws (at both locations)	2	Less than 0.05
5:	Water Availability (at both locations)	1	Less than 0.01
6:	Labor Availability (at both locations)	6	Less than 0.01
7:	Availability of Community Services (both during construction and during operations)	7	Less than 0.01

The responses received from energy conversion companies permitted additional analysis. Industrial concerns interested in constructing either electric generation facilities or coal gasification facilities responded to the survey. Consequently, the data were divided into two categories: (A) companies interested in constructing coal gasification facilities, and (B) companies interested in constructing both electric generation facilities and coal gasification plants. Of Group B, only two companies were interested in constructing both coal gasification and electric generation facilities.

The Kruskal-Wallis One-Way Analysis of Variance was applied to the segregated data to determine whether the two groups could be considered to come from the same population. Only the data of the

siting variables found to be statistically significant in the previous analysis were examined.

In conducting the Kruskal-Wallis test, each score is replaced by a rank. In this case, each rank was replaced by a derived rank, ranging from lowest to highest. Next, the groups are separated and an analysis of the distribution of ranks between groups is conducted. In the analysis of these data, a correction for ties was performed where the analysis indicated that significance was likely. Again, as above, the 0.10 level of significance was chosen.

The results of the Kruskal-Wallis analyses were as follows:

Form EC-1: A statistically significant difference between Groups A and B was found only on Item 11. The chance probability associated with the difference noted lies between 0.02 and 0.01.

Form EC-2: Again, a statistically significant difference between groups was found only on Item 11. Here the associated chance probability lies between 0.05 and 0.02.

Form EC-3: No significant differences were noted between Groups A and B on any of the items.

In Table II-11 are presented the summary statistics found in the analysis of each siting variable of Form 1 of the coal company survey. Statistics are presented only for those items found to be statistically significant. Included are the identity of the significant item, its modal rank and the chance probability of occurrence

associated with the observed difference between distributions. Five of the ten items on Form CC-1 were found to be statistically significant.

Table II-11: Identity, Modal Rank and Chance Probability of Occurrence for Significant Items - Form CC-1

Item	Modal Rank	Probability
1: Proximity to Market	9	0.10 greater than p greater than 0.05
3: Quantity of Coal	bimodal 1-2	Less than 0.01
4: Quality of Coal (BTU rating, sulfur, content, etc.)	3	Less than 0.01
8: Possibility of Future Mine-Mouth Energy Conversion	10	0.10 greater than p greater than 0.05
9: Availability of Leases (mineral rights)	1	Less than 0.01

Summary statistics of the analysis of siting variables included on Form CC-2 of the coal company survey are presented in Table II-12. The identity, modal rank and chance probability of each significant item are shown. Of the ten items listed in the survey, five were found to be statistically significant. Of the five significant items, four were identical to those found significant on Form CC-1.

Table II-12: Identity, Modal Rank, and Probability of Occurrence of Significant Items - Form CC-2

3:	Quantity of Coal	2	Less than 0.01
4:	Quality of Coal (BTU rating, sulfur content, etc.)	3	Less than 0.01
6:	Tax Structure (corporate taxes, coal taxes)	7	0.10 greater than p greater than 0.05
8:	Possibility of Future Mine-Mouth Energy Conversion	10	0.10 greater than p greater than 0.05
9:	Availability of Leases (mineral rights)	1	Less than 0.01

Discussion

The level of statistical significance for this study was set at 0.10. This low level was chosen because the study was a preliminary one and was conducted primarily to gain only an indication of what possible siting variables were considered important by industrial interests. Future studies should choose the customary 0.05 level of significance.

The results of the statistical analysis of the survey data allow the inference to be drawn that many of the survey items listed were considered unimportant by industry respondents. Responses to the energy conversion facility forms indicate that statistically

significant ranks were allotted to only four of thirteen items of Form EC-1, to six of thirteen items of Form EC-2 and to four of seven items of Form EC-3. Coal company responses to the survey demonstrated that only five of the ten items listed on Forms CC-1 and CC-2 were ranked in a statistically significant manner. Generally, those items for which significance was noted were ranked either very high or very low; only on Form EC-2 were "middle" ranks noted for significant items.

Energy Conversion Facility Forms: As expected, items relating to coal requirements and water requirements were ranked 1 and 2, respectively, on both Forms EC-1 and EC-2. On Form EC-1, the items relating to community service availability and the supply of construction and operation materials were ranked 11 and 13, respectively. The rank ascribed to the materials availability item is surprising in that government reports indicate that materials shortages are predicted and that these shortages will slow the construction of energy conversion facilities. The response of the companies may be attibuted to the fact that most materials essential to the construction and operation of energy conversion facilities are provided by suppliers outside the Northern Great Plains area. Hence, since very few suppliers exist within the Northern Great Plains area, that variable becomes largely academic.

The rank assigned the community service availability item, 11, also is surprising in that the effects of construction and operation force populations on those services are among the primary impacts noted by recent sociological and economic studies in coal development areas.

Clearly, while such impacts are extremely important to the affected populations and their governments, they are a low priority item at the industry level. This conclusion is supported by the fact that the public opinion item was not ascribed a statistically significant rank.

On Form EC-2, the materials availability item again received a low rank, 10, and the item relating to the availability of labor received a rank of 11. The latter rank is interesting in that it permits the assumption that the industry either assumes that skilled labor will be available on site to meet construction and operation demand or that such labor may be imported easily. Experience in Montana, at both dragline and thermal electric generation plant construction sites, has shown that labor must be imported. Some of the imported labor at the generation plant construction site has come from Canada. Items relating to siting regulations and environmental laws were ranked 5 and 6, respectively, in responses to Form EC-2.

It is interesting to note that items relating to tax structures, land requirements, market proximity, transportation facilities and

public acceptance did not receive statistically significant ranks on Forms EC-1 and EC-2.

On Form EC-3, the item relating to water availability received a rank of 1. The siting law item received a rank of 2. The items relating to labor availability and community service availability received the lowest ranks, 6 and 7, respectively. Again, the items referring to community acceptance, environmental laws and transportation availability were not ascribed statistically significant ranks.

The results of the Kruskall-Wallis One-Way Analysis of Variance permit the inference to be drawn that the energy conversion industry respondents were not dissimilar in their perceptions of the importance of the significant survey items. Only on Item 11 of Forms EC-1 and EC-2 was a significant difference noted between the responses of the coal gasification interests and the electricity generation-gasification interests. Item 11, relating to construction and operation materials availability was assigned a rank of 10 by the gasification interests and a bimodal rank of 12/13 by the electricity generation-gasification interests, a low rank in both cases.

Significant coal company responses to the survey were consistent between Forms CC-1 and CC-2. On both forms, items relating to lease availability, quantity of coal and quality of coal were rated 1, 2 and 3, respectively, as would be expected. On Form CC-1, the items referring to market proximity and the possibility of future mine-mouth industrialization received ranks of 9 and 10, respectively, the lowest ranks. On Form CC-2, the future industrialization item

again received a rank of 10 and the item relating to tax structures was assigned the moderately low rank of 7. As was the case with the energy conversion industry respondents, items dealing with legal constraints (environmental laws, reclamation laws), and public opinion were not assigned statistically significant ranks.

Government and industry officials frequently comment that tax structures are an important matter in the siting of coal strip mines; yet, this item received a low rank on Form CC-2, and no significant rank on Form CC-1. Similarly, reclamation laws are frequently mentioned as a deterrent to strip mining; yet, the reclamation item was not assigned a significant rank on either form.

The statistically significant responses of the energy conversion and coal mining industry respondents do display some consistence. Generally, both interests appear primarily concerned with issues of natural resource availability, as would be expected. However, it is interesting to note that several issues that one would assume relevant to the exploitation of those resources were either ranked very low in importance or were not significantly ranked at all. Items relating to the statutory context in which mines or energy conversion facilities must operate were not ranked by coal companies and received only a moderate rank on one form from energy conversion interests. Items relating to community impact, public acceptance of a project, and labor and materials

availability were assigned either very low ranks or no statistically significant rank at all. The responses to items that were not assigned significant ranks are quite variable, in some cases displaying trimodal distributions. In these circumstances, the data allow no statement to be made about the perceived importance of the siting variables.

Limitations of the Study

Response to the study was poor. Should interest warrant it, the study should be repeated and an attempt made to obtain numerically greater response from the coal and energy interests.

If such a study is repeated, more time should be spent on developing a survey instrument. Future attempts to elicit ranking of items should be accompanied by more explicit instructions. Respondents to this study often assigned the same rank to several items. This possibility should be precluded in future studies. In addition, future studies also should examine critical variables in opposite pairs such that respondents would be forced to make a decision as to the relative importance of each variable in comparison to each other variable. Such procedures may eliminate the variable responses to many variables that were noted in the present study.

Conclusion

A survey of energy conversion and coal industry interests was conducted in order to assess the relative importance of a number of variables thought pertinent to the siting of industrial operations. Response to the survey was disappointingly small. Data gathered in the survey was subjected to non-parametric statistical analysis. Of the variables listed, relatively few received statistically significant responses. Variables receiving significant response were ranked either very high or very low, with the exception of two variables on one survey form. Variables receiving high ranks related to the availability of natural resources. Variables receiving low ranks related to the social impacts of proposed operations, and the availability of labor and materials. The study was compromised by small numerical response and by insufficient instructions to respondents, which allowed them to assign identical ranks to several items. The study should be repeated with a greater sample size and more rigorous controls.

Scenarios of Alternative Futures

Having discussed the economy, energy in various aspects of economic activities, and some factors critical to industrial decision-making, we now move to a specific discussion of the future. Because no one can positively say what the future will bring in coal development, we have adopted three scenarios of alternative levels of coal development. Much of the work done on this study has been carried out in concert with the Northern Great Plains Resource Program (NGPRP). Thus, we have selected two of our three coal development scenarios from the NGPRP. These are the middle and high development scenarios. The low or baseline scenario was independently developed as a control level which assumes virtually no coal development. Although we know this low scenario is unrealistic, it provides a much more meaningful baseline with which the other can be compared and residuals attributable to coal can be calculated.[18/]

Where appropriate, these scenarios will be used in the following chapters as a unified focal point for tracing the ripples of coal-related development in Montana.

18/ This scenario is based on the middle range of economic projections prepared by the Montana Department of Natural Resources and Conservation for use in state water planning. Their publication is forthcoming.

Table II-13:
ALTERNATIVE FUTURE SCENARIOS, THE ROLE OF ENERGY AND MINERAL FUELS IN THE MONTANA ECONOMY

		SCENARIO I Virtually No Coal Development 1/	SCENARIO II Middle Range of Coal Development (NGPRP)	SCENARIO III Large-Scale Coal Development (NGPRP)
1970	Coal Production (10.6 Million Tons Per Year)	3.48	----	----
	Coal-Fired Generation on Line (MW Capacity)	230	----	----
	Coal Gasification on Line (MMCFD Capacity)	0	----	----
	Total Population	694,409	----	----
	Total Employment	248,342	----	----
1980	Coal Production	3.5	41	64
	Coal-Fired Generation	230	2,050	2,050
	Coal Gasification	0	0	750
	Total Population	740,128	760,128	797,128
	Total Employment	261,320	270,300	291,300
1985	Coal Production	3.5	75	153
	Coal-Fired Generation	230	2,500	2,500
	Coal Gasification	0	750	2,000
	Total Population	761,573	817,573	841,573
	Total Employment	271,088	298,100	307,100
2000	Coal Production	3.5	133	393
	Coal-Fired Generation	230	6,360	6,360
	Coal Gasification	0	1,500	3,750
	Total Population	825,910	889,910	969,910
	Total Employment	301,563	325,600	357,600

1/ See footnote on preceding page.

Scenario I, Virtually No Development, is certainly unrealistic. The changes from 1970 to the present have already proven it wrong. Its real value is as a reference line.

Scenarios II and III, from NGPRP, differ in the levels of coal production and the scope of gasification. Coal-fired steam generation remains the same in each.

Although arbitrary, the NGPRP projections are the best available base for economic forecasts. In recent communications, NGPRP Program Manager, John VanDerwalker, noted recent trends indicating actual 1980 and 1985 regional coal production will be intermediate to Scenarios II and III.

Earlier in this chapter, we set forth conservative coal production projections to 1980, primarily based on coal sales contracts. The 1980 projection is slightly in excess of NGPRP Scenario II production levels.

Shell Oil's Crow Reservation project (possible eight million tons by 1980) and Burlington Northern's proposed fertilizer, methanol and synthic diesel fuel operation are not included. Some of the corporations actively drilling Montana coal may be in a position to open new mines by 1980. All four of the existing export mines have one or more draglines on order.

In that each new operation or mine expansion is subject to Montana strip mine siting and reclamation laws, it seems futile to

make post-1980 company specific projections. State approval is by no means automatic. Accordingly, we can only conclude that Montana's 1980 and 1985 coal production will be intermediate to Secnarios II and III.

CHAPTER III

EMPLOYMENT AND POPULATION

The employment and population effects of coal-related development are necessarily dependent upon the characteristics of the primary development activity. Furthermore, these impacts will have a varying effect in terms of significance depending on the impact area under consideration. For purposes of this discussion, we will focus on two geographic approaches.

The first involves consideration of the effect on the Montana economy and population. That is, net employment and population effects at the state level. This is not a totally satisfactory way of looking at coal-related effects, however, because experience and economic theory both suggest that many of the effects will be very localized. Furthermore, many of the peaks caused by development will be strongly localized in impact. For example, while the construction effects of a generating station may not be particularly significant at the state level, the imposition of a large number of workers on a small rural community can place almost astronomical pressures on local public and private services.

The second will be upon a localized impact area. Some of the information presented here would, of course, have to be modified or manipulated for other areas if one had information that suggested some other area was going to feel the impact.

In addition to separating out two geographic points of view, there is also an extreme difference between construction and long-term operation periods in an activity's lifetime.

The subject area of this section is a matter of considerable interest in governmental, university and private studies these days. Recent Montana studies such as "Water Use and Coal Development in Eastern Montana" by Paul E. Polzin, The Interim Report of the Northern Great Plains Resource Program, and the draft environmental impact statement on "Colstrip Electric Generating Units 3 & 4, 500 Kilovolt Transmission Lines and Associated Facilities" all devote considerable attention to this matter. And although the focus of each is somewhat different, the interested reader is referred to each as a credible source of information on primary economic impact as a result of the construction and operation of a coal-based facility or broad complex, as the respective case may be.

Statewide Impact

Table III-1 on the following page, showing Montana population and employment under the three development scenarios, paints a quick sketch of the potential impact to the total Montana economy under the three alternative levels of activity.

Table III-1: Montana Population and Employment Under Three Development Scenarios

		Scenario I Virtually No Coal Development	Scenario II Middle Range of Coal Development	Scenario III Large-Scale Coal Development
1970	Population	694,409		
	Employment	248,342		
1980	Population	740,128	761,128	797,128
	Employment	261,320	270,300	291,300
1985	Population	761,573	817,573	841,573
	Employment	271,088	298,100	307,100
2000	Population	825,910	889,910	969,910
	Employment	301,563	325,600	357,600

A word of explanation about the three scenarios. Scenarios II and III are taken directly from the Northern Great Plains Resource Program's Draft Interim Report of September 1974. In turn, NGPRP based its scenarios upon an extensive study carried out by U.S. Bureau of Mines Washington personnel for NGPRP Work Group G, National Energy Considerations. As the title might suggest to those who are familiar with the study or who read between the lines, the work of this group, although of great magnitude and high quality, is most valid at the national level. National projections were disaggregated to the Northern Great Plains Region and then the Northern Great Plains' share was further allocated to the member states. In the face of

time constraints and external pressure from the Federal Energy Administration, the small team of federal energy experts in Washington did an admirable job for the NGPRP -- a predominantly federal study. This is pointed out here because this report (The Role of Energy and Mineral Fuels in the Montana Economy), while using these projections, is neither stating nor implying that these scenarios reflect MEAC's best current judgment of what is expected to occur vis-a-vis coal development in Montana. Because there is still such great uncertainty as to what will happen as far as coal production and, particularly the disposition and refining of coal, the NGPRP scenarios are presented as well as those of Polzin. Scenario I, developed by the Montana Department of Natural Resources and Conservation for the State Water Plan, has been used as a baseline because of the feeling that it more adequately reflects a "no coal" future for the state. It is based on decennial census data back to 1930 and uses regression to project into the future. By its use, the analyst can calculate more meaningful residuals which can be assigned to coal-related activities.

Table III-2 presents the total population and employment, as well as an employment breakdown, all of which are attributable to coal development in Montana. Further, it shows these numbers as a percentage of Scenario I. Thus, if Scenario II occurs, the associated impact might be expected to account for a 2.8 percent increase in

total Montana population over what would otherwise occur in 1980. The highest percentages appear in the High Development Scenario (III) in the year 2000. In that case, it is estimated that total population directly and indirectly attributable to coal development would account for an increase of 17.4 percent over what would otherwise have occurred. The employment addition under these assumptions would be 18.6 percent additional jobs.

Table III-2: Total Population and Employment Attributable to Coal Development in Montana, Scenarios II and III, 1980, 1985, 2000 1/; and as a Percentage of Scenario I (No Coal) Totals 2/

	1980		1985		2000	
Scenario II						
Population	21,000	2.8%	56,000	7.3%	64,000	7.7%
Employment						
Direct Operating	1,000	.4%	4,000	1.5%	6,000	2.0%
Construction	1,000	.4%	3,000	1.1%	1,000	.3%
Indirect	7,000	2.7%	20,000	7.4%	17,000	5.6%
Total	9,000	3.4%	27,000	10.0%	24,000	7.9%
Scenario III						
Population	57,000	7.7%	80,000	10.5%	144,000	17.4%
Employment						
Direct Operating	4,000	1.5%	7,000	2.6%	14,000	4.6%
Construction	4,000	1.5%	3,000	1.1%	2,000	.7%
Indirect	22,000	8.4%	26,000	9.6%	40,000	13.3%
Total	30,000	11.5%	36,000	13.3%	56,000	18.6%

1/ From NGPRP Interim Report
2/ Calculated by MEAC.

A More Localized Impact

There are two major studies completed to date which focus directly on the economic impact of a more localized nature associated with coal development. Their findings will be discussed here. The first is "Water Use and Coal Development in Eastern Montana," by Dr. Paul Polzin. In his study which looks to 1985, Polzin has specified a three-county primary impact area and a larger seven-county economic impact area. The primary impact area includes Big Horn, Powder River, and Rosebud Counties. This choice was largely dependent on NGPRP studies which indicated that sites in this area were most promising for development. His larger economic impact area added Custer, Musselshell, Treasure and Yellowstone Counties. Polzin very carefully (and wisely) adds that his selection of these study areas does not rule out coal development elsewhere in Montana.

Table III-3 is taken directly out of Polzin's document, and spells out the components of the two scenarios he considers.

Tables III-4 and III-5 also directly out of Polzin, detail the employment and earnings associated with his two scenarios for 1980 and 1985. These do not include construction. Tables III-6 and III-7 (from Polzin) summarize employment and population.

Polzin has recognized the significance of construction, and has elected to treat it separately. He has taken standard scales

Table III-3

Projected Alternative Levels of Coal Development
with and without Gasification
1980 and 1985

	Alternative I (No Gasification)		Alternative II (With Gasification)	
	1980	1985	1980	1985
Montana coal production, total (millions of tons)	49.0	61.0	57.0	77.0
Shipped from Montana	39.5	47.5	39.5	47.5
Used for electrical generation[a]	9.5	13.5	9.5	13.5
Used for gasification	0	0	8.0	16.0
Additional electrical generation (installed megawatts)[b]	2,060	3,060	2,060	3,060
Gasification plants (250 million scfd)[c]	0	0	1	2

[a]Includes 0.5 million tons per year for the Corette plant but excludes 0.33 million tons mined in Richland County (Montana-Dakota Utilities Co.).

[b]Excludes the Corette plant.

[c]scfd denotes standard cubic feet per day.

Table III-4

Projected Employment and Earnings in the Economic Impact Area
Alternative 1 -- No Gasification
1980 and 1985

	Projected 1980		Projected 1985	
	Employment	Earnings[a]	Employment	Earnings[a]
Coal-related industries				
Mining	1,017	$15,052,000	1,175	$19,505,000
Export	820	12,136,000	915	15,189,000
Montana residents	685	10,138,000	790	13,114,000
Wyoming residents	135	1,998,000	125	2,075,000
Electrical generation	197	2,916,000	260	4,316,000
Gasification	0	0	0	0
Electrical generating plants	175	2,433,000	260	4,082,000
Gasification plants	0	0	0	0
Railroads (unit train operations only)				
Three-county impact area[b]	192	2,996,000	204	3,590,000
Seven-county impact area[c]	480	7,488,000	510	8,976,000
Coal-related industries, total				
Three-county impact area[b]	1,384	20,481,000	1,639	27,177,000
Montana residents	1,249	18,483,000	1,514	25,102,000
Seven-county impact area[c]	1,672	24,973,000	1,945	32,563,000
Montana residents	1,537	22,975,000	1,820	30,488,000
Impact on agriculture				
Acres disturbed (cumulative, from 1970)	5,300		11,400	
Change in farm receipts per year[a]	-$159,000		-$342,000	
Change in farm earnings per year[a]	-$ 95,400		-$205,200	
Derivative industries, total[d]				
Three-county impact area[b]	1,280	9,218,000	1,420	12,500,000
Seven-county impact area[c]	4,011	32,086,000	4,621	42,512,000
All industries, total[d]				
Three-county impact area[b]	2,529	27,606,000	2,934	37,397,000
Seven-county impact area[c]	5,548	54,966,000	6,441	72,795,000

[a] In 1970 dollars.

[b] Big Horn, Powder River, and Rosebud counties.

[c] Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure, and Yellowstone counties.

[d] Montana residents only.

Table III-5

Projected Employment and Earnings in the Economic Impact Area
Alternative II -- With Gasification
1980 and 1985

	Projected 1980		Projected 1985	
	Employment	Earnings[a]	Employment	Earnings[a]
Coal-related industries				
Mining	1,183	$17,509,000	1,483	$ 24,618,000
Export	820	12,136,000	915	15,189,000
Montana residents	685	10,138,000	790	13,114,000
Wyoming residents	135	1,998,000	125	2,075,000
Electrical generation	197	2,916,000	260	4,316,000
Gasification	166	2,457,000	308	5,113,000
Electrical generating plants	175	2,433,000	260	4,082,000
Gasification plants	625	7,938,000	1,250	17,875,000
Railroads (unit train operations only)				
Three-county impact area[b]	192	2,996,000	204	3,590,000
Seven-county impact area[c]	480	7,488,000	510	8,976,000
Coal-related industries, total				
Three-county impact area[b]	2,175	30,876,000	3,197	50,165,000
Montana residents	2,040	28,878,000	3,072	48,090,000
Seven-county impact area[c]	2,463	35,368,000	3,503	55,551,000
Montana residents	2,328	33,370,000	3,378	53,476,000
Impact on agriculture				
Acres disturbed (cumulative from 1970)	5,480		12,700	
Change in farm receipts per year[a]	-$164,400		-$381,000	
Change in farm earnings per year[a]	-$ 98,600		-$228,600	
Derivative industries total[d]				
Three-county impact area[b]	1,872	14,414,000	2,636	23,988,000
Seven-county impact area[c]	5,687	46,636,000	7,860	74,676,000
All industries, total[d]				
Three-county impact area[b]	3,912	43,193,000	5,708	71,849,000
Seven-county impact area[c]	8,015	79,907,000	11,238	127,923,000

[a] In 1970 dollars.

[b] Big Horn, Powder River, and Rosebud counties.

[c] Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure, and Yellowstone counties.

[d] Montana residents only.

Table III-6

Total Employment in the Economic Impact Areas
with and without Coal Development
1970 and Projected 1980 and 1985

	1970	Projected 1980	Projected 1985
Three-county impact area[a]			
With no coal development	7,500	7,500	7,600
With coal development			
Alternative I -- no gasification	7,500	10,029	10,534
Alternative II -- with gasification	7,500	11,412	13,308
Seven-county impact area[b]			
With no coal development	51,700	51,700	53,100
With coal development			
Alternative I -- no gasification	51,700	57,248	59,541
Alternative II -- with gasification	51,700	59,715	64,338

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economics Information System, unpublished data (Washington, D.C., 1973); and *idem*, OBERS Projections, unpublished data (Washington, D.C., 1973), derived. The projections under Alternatives I and II were developed by the University of Montana, Bureau of Business and Economic Research (Missoula, Montana).

[a]Big Horn, Powder River, and Rosebud counties.

[b]Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure, and Yellowstone counties.

Table III-7

Population and Net Migration in the Economic Impact Areas with and without Coal Development 1970 and Projected 1980 and 1985

	1970	Projected 1980	Projected 1985
Population			
Three-county impact area[a]			
With no coal development	18,951	NA	NA
With coal development			
Alternative I -- no gasification	18,951	23,650	25,100
Alternative II -- with gasification	18,951	26,150	30,350
Seven-county impact area[b]			
With no coal development	123,295	129,600	132,800
With coal development			
Alternative I -- no gasification	123,295	135,150	143,150
Alternative II -- with gasification	123,295	139,700	152,550

	1960-1970	Projected 1970-1980	Projected 1980-1985
Net migration[c]			
Three-county impact area[a]			
With no coal development	-2,528	NA	NA
With coal development			
Alternative I -- no gasification	-2,528	2,070	- 568
Alternative II -- with gasification	-2,528	4,539	1,829
Seven-county impact area[b]			
With no coal development	-8,182	-8,103	-5,313
With coal development			
Alternative I -- no gasification	-8,182	-2,720	-1,216
Alternative II -- with gasification	-8,182	1,789	3,072

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Analysis Projections System, OBERS Projections, unpublished data (Washington, D.C., 1973); and U.S. Department of Commerce, Bureau of the Census, *U.S. Census of Population and Housing: 1970, General Demographic Trends for Metropolitan Areas, 1960 to 1970, Montana*, PHC(2)-28 (Washington, D.C.: U.S. Government Printing Office, 1971), table 3, pp. 28-10 and 28-11. The population projections under Alternatives I and II and all the net migration projections were developed by the University of Montana, Bureau of Business and Economic Research (Missoula, Montana).

NA denotes not available.

[a] Big Horn, Powder River, and Rosebud counties.

[b] Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure, and Yellowstone counties.

[c] A negative figure denotes net outmigration from the area.

of coal activities -- (1) a ten million ton per year coal strip mine; (2) a 500 megawatt electrical generation plant; and (3) a 240 million scfd. coal gasification plant -- and outlined a construction profile for each in his study area. Each profile is for 1980, and includes population, as well as primary and derivative employment and earnings. These profiles, Tables III-8 and III-9 and III-10 follow.

Table III-11 is taken from "The Economic Impact of Proposed Colstrip Unit 3 and 4 on the Rosebud County Economy" prepared by the Montana Department of Intergovernmental Relations for the Energy Planning Division, Montana Department of Natural Resources and Conservation. This is an unpublished paper. The three scenarios are shown in Table III-12.

Table III-12: Economic Growth Scenarios

	Generation Units	Western Energy Coal Production
Scenario I (minimum growth)	Plants 1, 2	Coal for Plants 1, 2. Current existing sales contracts.
Scenario II (coal export)	Plants 1, 2	Coal for Plants 1, 2. Current existing sales contracts. Additional contracts equivalent to Plants 3 and 4 requirements, but exported from state.
Scenario III (with 3 and 4)	Plants 1, 2, 3 and 4	Coal for Plants 1, 2, 3 and 4. Current existing sales contracts.

Table III-8

Construction Profile for a 10 Million Tons per Year Coal Surface Mine
in the Economic Impact Area
1980

	Year 1		Year 2	
	Employment (Annual Average)	Earnings (In 1970 Dollars)	Employment (Annual Average)	Earnings (In 1970 Dollars)
Primary industries (construction)	150	$2,250,000	250	$3,750,000
Derivative industries				
Three-county impact area[a]	78	562,500	130	937,500
Seven-county impact area[b]	197	1,575,000	328	2,625,000
All industries, total				
Three-county impact area[a]	228	2,812,500	380	4,687,500
Seven-county impact area[b]	347	3,825,000	578	6,375,000
Population				
Three-county impact area[a]	450		750	
Seven-county impact area[b]	700		1,150	

[a] Big Horn, Powder River, and Rosebud counties.

[b] Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure, and Yellowstone counties.

Table III-9

Construction Profile for a 500 Megawatt Electrical Generation Plant
in the Economic Impact Area
1980

	Year 1		Year 2		Year 3	
	Employment (Annual Average)	Earnings (In 1970 Dollars)	Employment (Annual Average)	Earnings (In 1970 Dollars)	Employment (Annual Average)	Earnings (In 1970 Dollars)
Primary industries (construction)	470	$ 7,050,000	940	$14,100,000	470	$ 7,050,000
Derivative industries						
Three-county impact area[a]	245	1,762,500	490	3,525,000	245	1,762,500
Seven-county impact area[b]	617	4,935,000	1,234	9,870,000	617	4,935,000
All industries, total						
Three-county impact area[a]	715	8,812,500	1,430	17,625,000	715	8,812,500
Seven-county impact area[b]	1,087	11,985,000	2,174	23,970,000	1,087	11,985,000
Population						
Three-county impact area[a]	1,450		2,850		1,450	
Seven-county impact area[b]	2,200		4,350		2,200	

Note: This profile excludes construction of an associated coal mine.

[a] Big Horn, Powder River, and Rosebud counties.

[b] Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure, and Yellowstone counties.

Table III-10

Construction Profile for a 250 Million scfd Gasification Plant
in the Economic Impact Area
1980

	Year 1		Year 2		Year 3		Year 4[a]	
	Employment (Annual Average)	Earnings (In 1970 Dollars)	Employment (Annual Average)	Earnings (In 1970 Dollars)	Employment (Annual Average)	Earnings (In 1970 Dollars)	Employment (Annual Average)	Earnings (In 1970 Dollars)
Primary industries (construction)	840	$12,600,000	2,190	$32,850,000	2,040	$30,600,000	315	$4,725,000
Derivative industries								
Three-county impact area[b]	438	3,150,000	1,141	8,212,500	1,063	7,650,000	164	1,181,250
Seven-county impact area[c]	1,103	8,820,000	2,874	22,995,000	2,678	21,420,000	413	3,307,500
All industries, total								
Three-county impact area[b]	1,278	15,750,000	3,331	41,062,500	3,103	38,250,000	479	5,906,250
Seven-county impact area[c]	1,943	21,420,000	5,064	55,845,000	4,718	52,020,000	728	8,032,500
Population								
Three-county impact area[b]	2,550		6,650		6,200		950	
Seven-county impact area[c]	3,900		10,100		9,450		1,450	

Notes: This profile excludes construction of an associated coal mine. The abbreviation scfd denotes standard cubic feet per day.

[a]Six months actual working time.

[b]Big Horn, Powder River, and Rosebud counties.

[c]Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure, and Yellowstone counties.

Table III-11

Rosebud County Total Earnings, Personal Income, Employment, Population and Growth Rates, 1920 - 1981, Three Scenarios (% Change)

		Earnings (000$) (1)	P.I. (000$) (2)	Percent Change	Employ. (3)	Pop.	Percent Change
Actual	1920					8002	
	1929	2866	3194				
	1930					7347	- 8.2
	1940	3026	3325	+ 4.1		6477	-11.8
	1950	8698	9795	+195.6		6570	+ 1.4
	1959	10572	12434	+ 26.9		6100	- 7.2
	1960					6187	+ 1.4
	1962	12158	14241	+ 14.5		6100	- 1.4
	1965	9705	12483	- 12.3		5900	- 3.3
	1966	9467	12353	- 1.1		6200	+ 5.1
	1967	10326	13527	+ 9.5	2569	8100	- 1.6
	1968	11955	15156	+ 14.2	2544	6100	N. C.
	1969	13564	17390	+ 12.5	2506	6100	N. C.
	1970	14836	19094	+ 9.8	2550	6032	- 1.1
	1971	16570	21069	+ 10.3	2782	6100	+ 1.1
	1972	19412	24191	+ 14.8	2909	6400	+ 4.9
Projected	1973-I	28298	34762	+ 44.7	3333	7766	+21.3
	II	28298	34762	+ 44.7	3333	7766	+21.3
	III	28298	34762	+ 44.7	3333	7766	+21.3
	1974-I	43133	52984	+ 52.4	4611	10744	+38.3
	II	43133	52984	+ 52.4	4611	10744	+38.3
	III	43133	52984	+ 52.4	4611	10744	+38.3
	1975-I	40835	50161	- 5.3	4604	10727	- 0.2
	II	40835	50161	- 5.3	4604	10727	- 0.2
	III	47374	58194	+ 9.8	5112	11911	+10.9
	1976-I	37164	45633	- 9.0	4437	10338	- 3.6
	II	37164	45653	- 9.0	4437	10338	- 3.6
	III	57653	70797	+ 82.2	6114	14246	+19.6
	1977-I	35517	43629	- 4.4	4347	10129	- 2.0
	II	35517	43629	- 4.4	4347	10129	- 2.0
	III	64850	79638	+ 12.5	6932	16152	+15.8
	1978-I	36344	44645	+ 2.3	4388	10224	+ 0.9
	II	37225	45728	+ 4.8	4455	10380	+ 2.5
	III	56458	69353	- 12.9	6489	15119	- 6.4
	1979-I	37485	46046	+ 3.1	4464	10401	+ 2.9
	II	40262	49458	+ 8.2	4685	10901	+ 5.6
	III	49771	61138	- 11.8	5967	13903	- 8.0
	1980-I	36663	45057	- 2.2	4392	10253	- 1.6
	II	40576	49844	+ 0.8	4725	11009	+ 1.0
	III	45935	56426	- 7.7	5577	12994	- 6.5
	1981-I	36778	45178	+ 0.3	4376	10196	- 0.4
	II	40966	50322	+ 1.0	4757	11084	+ 0.7
	III	45251	55586	0.0	5417	12622	- 2.9

N.C. = No Change

(1), (2) 1927-'72 (Current Dollars) 1973-'81 (1973 Dollars)

(3) Residence Adjusted Construction Industry

Source: U.S. Department of Commerce, Bureau of Census, Bureau of Economic Analysis Research, and Information Systems Div., MT Dept. of IGR

Construction

It is meaningful to look at construction impacts, particularly at ex aute estimates of labor force, and at the recent accuracy of such ex aute estimates. Because Montana's only experience with coal processing in the seventies is at Colstrip, we will look there.

Recently, information has become available which indicates that early estimates of peak construction work force may be considerably lower than what will actually occur. The most recent estimates available at this writing were provided by Montana Power and were prepared by the Bechtel Company, their contractor. These estimates, forecasting manpower loading by skills, anticipate a peak of over 1,550 total personnel involved in construction. They can be found in Figures III-1 and III-10. This contrasts with a construction peak of 1000 for the entire Colstrip Project (Units 1 through 4) as forecast in the report prepared by Westinghouse for Montana Power. We have no indications from the company that these most recent estimates will be exceeded. We can, however, look at the actual experience with Units 1 and 2 and with the Jim Bridger complex in Rock Springs, Wyoming.

First, Colstrip 1 and 2: From the final EIS on Colstrip 1 and 2, prepared by the Department of Health and Environmental Sciences, employment during construction was forecast to peak at 800-900 men. As of September 17, 1974, the work force associated

with the Western Energy operation (construction, mining and other) was as follows:

Plant construction	1,083
Mining	150
Other construction, service and railroad construction	190
Total Work Force	1,423

A look at the Jim Bridger Plant, originally planned as a 1500 megawatt complex, now under construction in Rock Springs, Wyoming, portrays a tale of a series of peak construction work force estimates -- each higher than its predecessor. In 1970, a projection was released predicting a peak work force in 1974 of 920. In 1972, a projection covering 1972 and 1973 was released which called for a peak of 1,300 in 1973. In early 1974, a new projection was released which showed a peak work force of 3,000. This peak was attained in the summer of 1974. In late 1974, the co-owners of the project announced that they would expand their plant from 1,500 megawatts to 2,000 megawatts. Therefore, this most recent projection can be assumed to be out of date.

Reasons given for the underestimate of the work force at the Jim Bridger plant include poor weather, material shortages, skilled labor shortages and other circumstances. It would appear that considerable research would be necessary to isolate the specific

causes of the situation. It does seem clear, however, that labor force projections are quite variable under the pressure of changing circumstances, and that this variability must be taken into explicit account in making public and private planning decisions.[19/]

The important point in this discussion is that there is considerable recent experience where peak work force estimates significantly underestimated the actual. We cannot say that the most recent estimates provided by Montana Power are low, but we must recognize that potentiality.

The next question is: "What is the capacity of the Montana labor pool to provide the numbers and types of workers which are forecast as required?" Presently, (Sept. 1974) at Colstrip, shortages exist for fifty (50) workers in the categories of electrician, pipefitter and pipefitter-welder. Presently no surplus of workers exists except in the categories of operating engineers and laborers. It is estimated that some 15 percent of the present construction work force are from outside Montana, with most of those coming from Texas and the surrounding southern states.

Plant construction in adjacent states and the Trans-Alaska Pipeline will significantly reduce the number of workers in this region of the nation. The Montana State Employment Service estimates

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19/ Comments on the Jim Bridger plant are based on correspondence with the Wyoming Dept. of Economic Planning and Development.

that in the construction of Colstrip 3 and 4, moderate to extreme shortages could periodically develop for electricians, iron workers, pipefitters, boilermakers and carpenters. No shortages of operating engineers for site preparation or laborers would be anticipated. In conclusion, it would appear that a large percentage of plant construction workers would have to be obtained outside the State of Montana, and in some cases, perhaps through the importation of foreign workers. These determinations are based on an approximate peak plant construction work force for Colstrip 3 and 4 of 1,500 workers, not including contingency operations.[20/]

Additionally, Figure III-11 plots Montana Department of Labor and Industry employment projections for the three major mines employing Montanans, to 1985.

20/ This labor market analysis is based on correspondence with the Montana State Employment Service.

Figure III-1

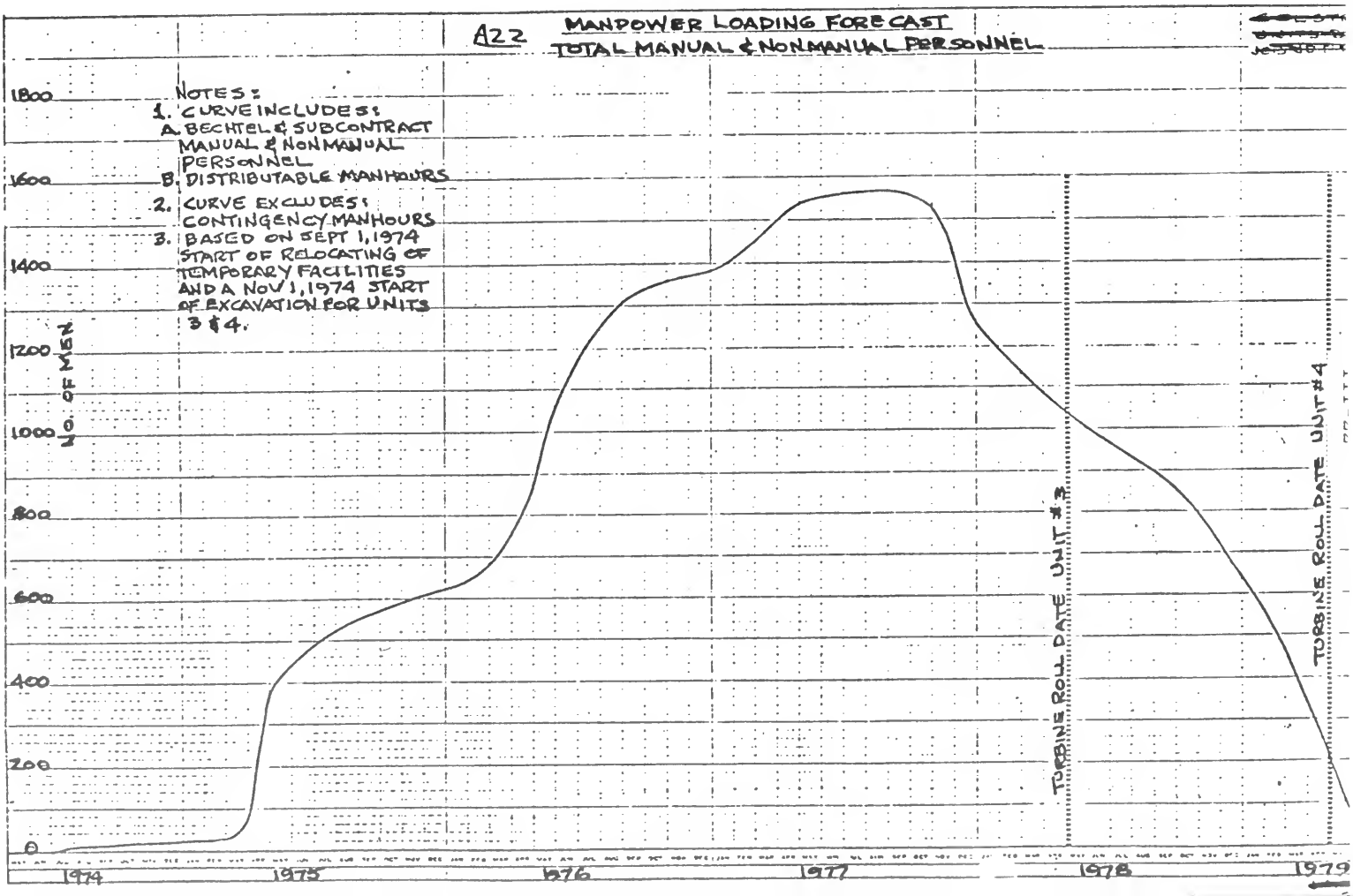

A22
MANPOWER LOADING FORECAST
TOTAL MANUAL & NONMANUAL PERSONNEL
NOTES:
1. CURVE INCLUDES:
A. BECHTEL & SUBCONTRACT MANUAL & NONMANUAL PERSONNEL
B. DISTRIBUTABLE MANHOURS
2. CURVE EXCLUDES:
CONTINGENCY MANHOURS
3. BASED ON SEPT 1, 1974 START OF RELOCATING OF TEMPORARY FACILITIES AND A NOV 1, 1974 START OF EXCAVATION FOR UNITS 3 & 4.
1800
1600
1400
1200
1000
800
600
400
200
0
NO. OF MEN
TURBINE ROLL DATE UNIT #3
TURBINE ROLL DATE UNIT #4
1974
1975
1976
1977
1978
1979

Figure III-2

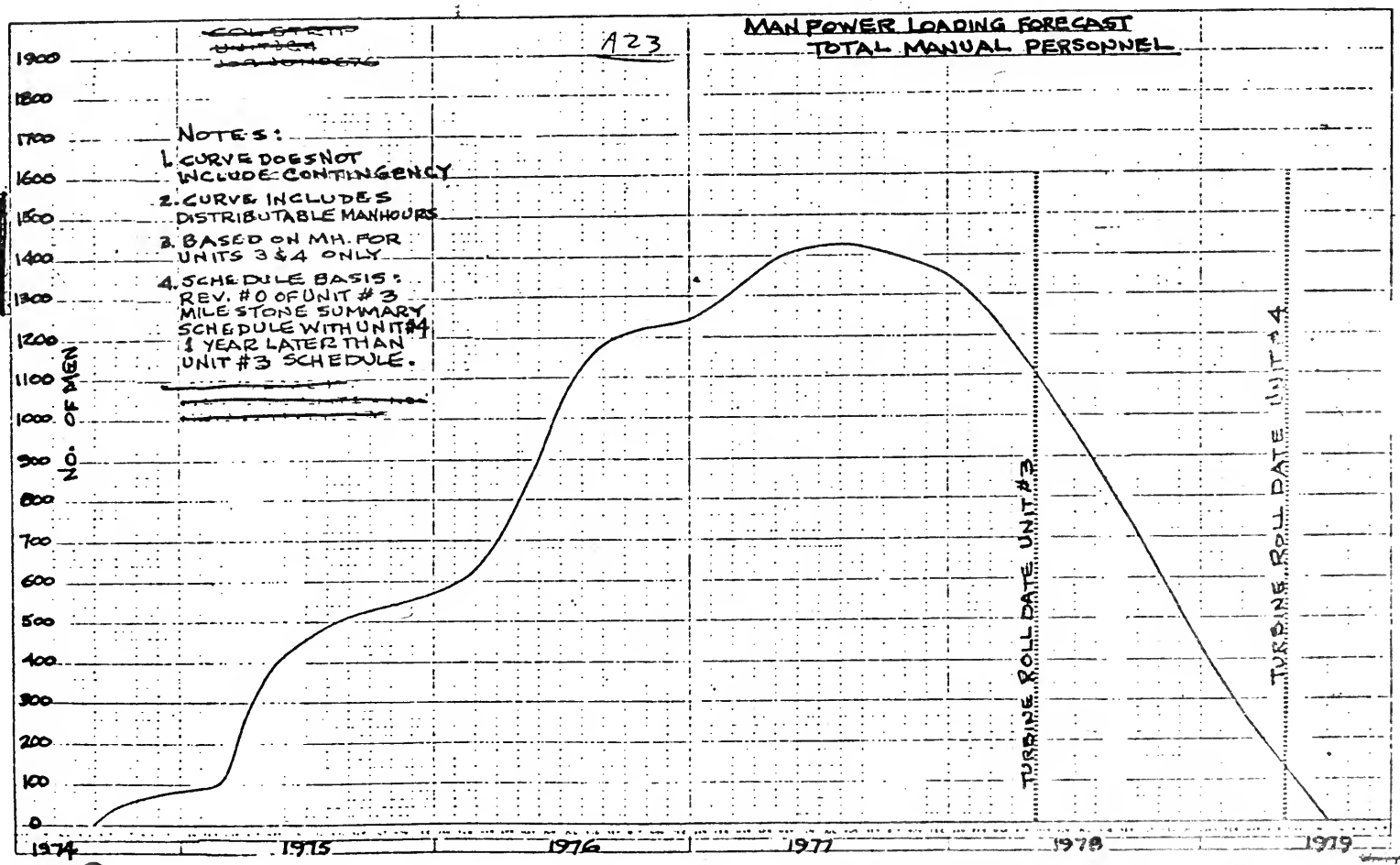

MAN POWER LOADING FORECAST
TOTAL MANUAL PERSONNEL
A23
NOTES:
1. CURVE DOES NOT INCLUDE CONTINGENCY
2. CURVE INCLUDES DISTRIBUTABLE MANHOURS
3. BASED ON MH. FOR UNITS 3 & 4 ONLY
4. SCHEDULE BASIS: REV. #0 OF UNIT #3 MILESTONE SUMMARY SCHEDULE WITH UNIT #4 1 YEAR LATER THAN UNIT #3 SCHEDULE.
NO. OF MEN
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1974
1975
1976
1977
1978
1979
TURBINE ROLL DATE UNIT #3
TURBINE ROLL DATE UNIT #4

Figure III-3

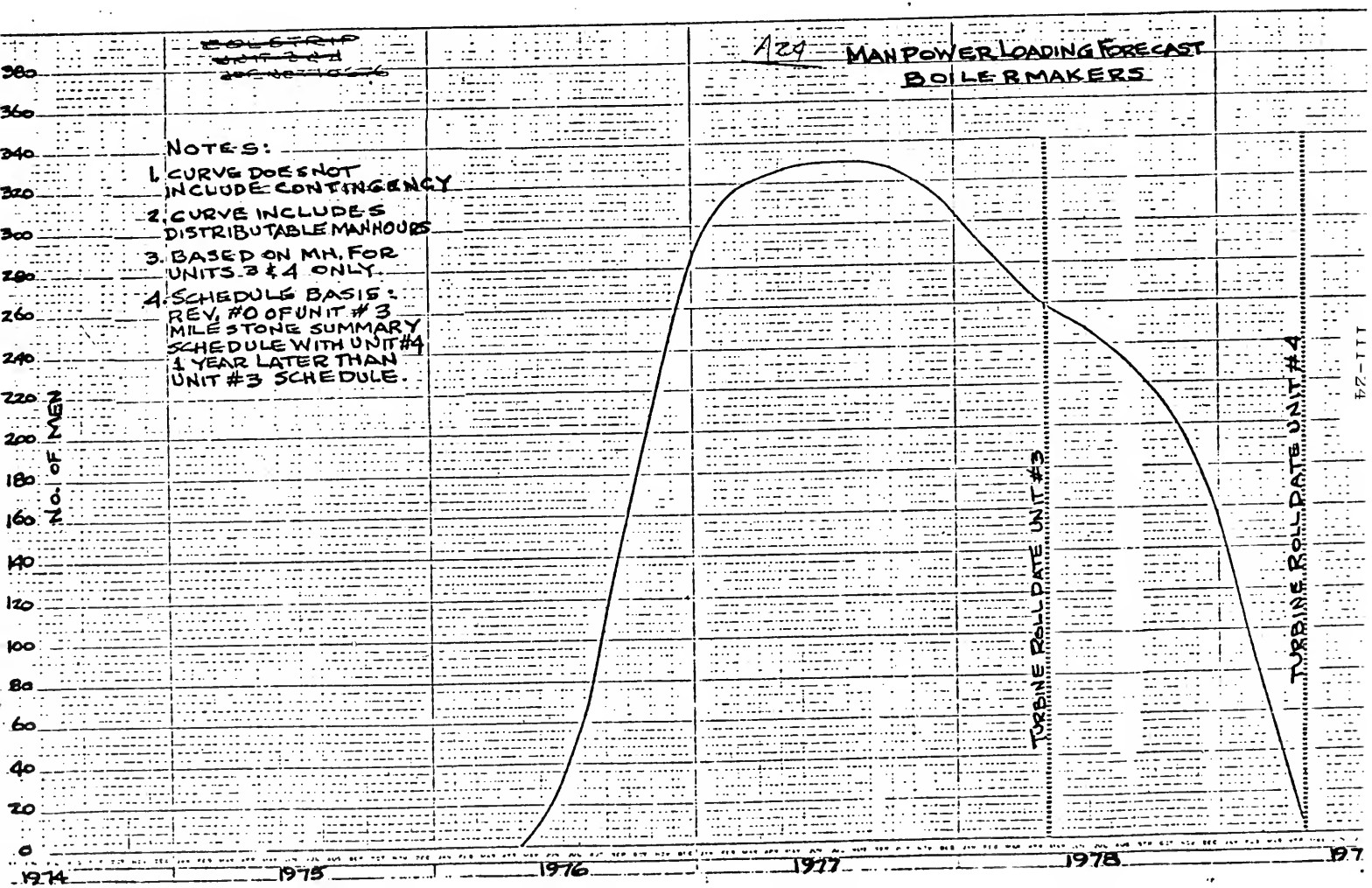

A24 MAN POWER LOADING FORECAST
BOILERMAKERS
NOTES:
1. CURVE DOES NOT INCLUDE CONTINGENCY
2. CURVE INCLUDES DISTRIBUTABLE MANHOURS
3. BASED ON MH. FOR UNITS 3 & 4 ONLY.
4. SCHEDULE BASIS: REV. #0 OF UNIT #3 MILESTONE SUMMARY SCHEDULE WITH UNIT #4 1 YEAR LATER THAN UNIT #3 SCHEDULE.
NO. OF MEN
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
1974
1975
1976
1977
1978
197
TURBINE ROLL DATE UNIT #3
TURBINE ROLL DATE UNIT #4

Figure III-4

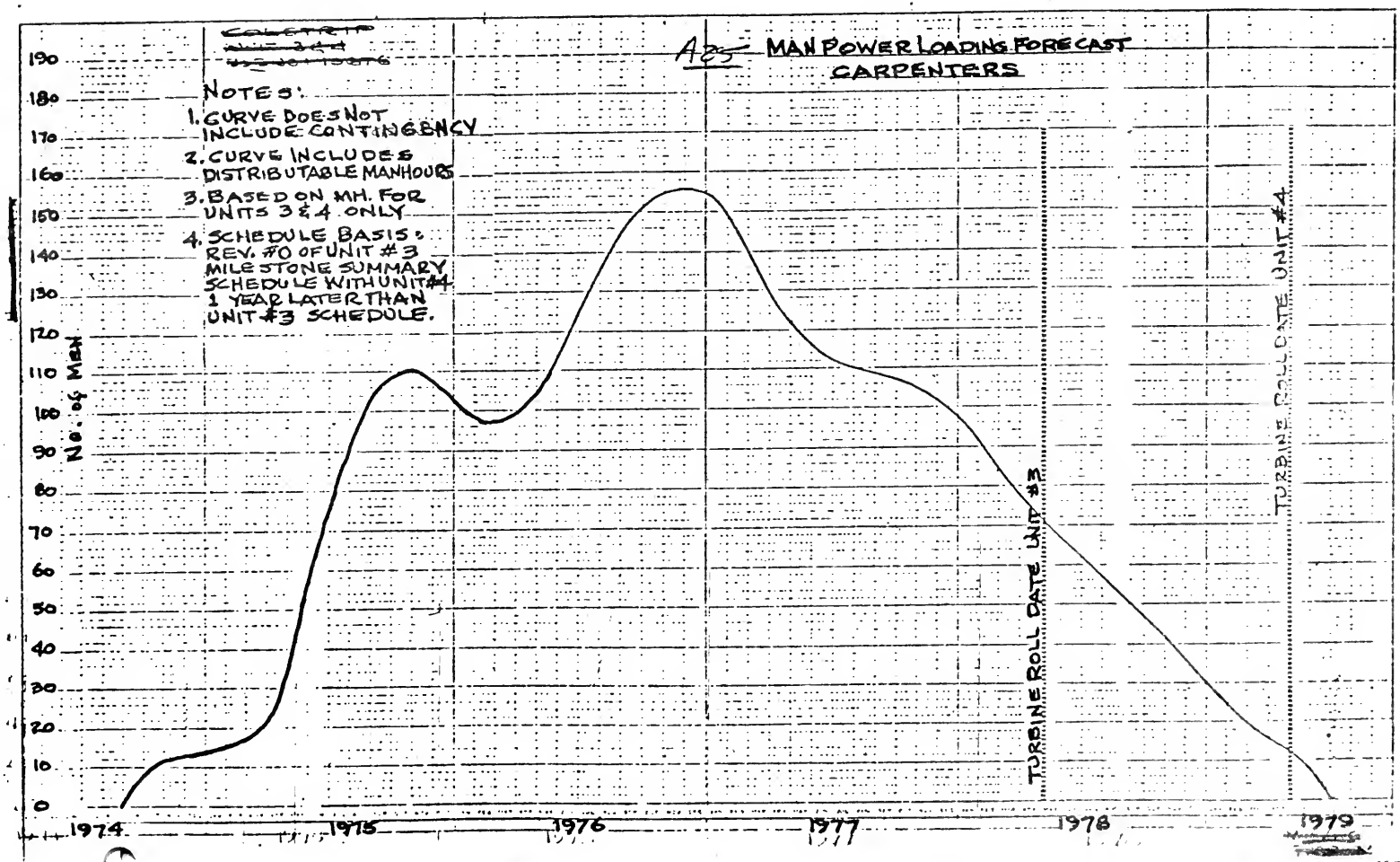

A25 MAN POWER LOADING FORECAST
CARPENTERS
NOTES:
1. CURVE DOES NOT INCLUDE CONTINGENCY
2. CURVE INCLUDES DISTRIBUTABLE MANHOURS
3. BASED ON MH. FOR UNITS 3 & 4 ONLY
4. SCHEDULE BASIS: REV. #0 OF UNIT #3 MILESTONE SUMMARY SCHEDULE WITH UNIT #4 1 YEAR LATER THAN UNIT #3 SCHEDULE.
NO. OF MEN
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1974
1975
1976
1977
1978
1979
TURBINE ROLL DATE UNIT #3
TURBINE ROLL DATE UNIT #4

Figure III-5

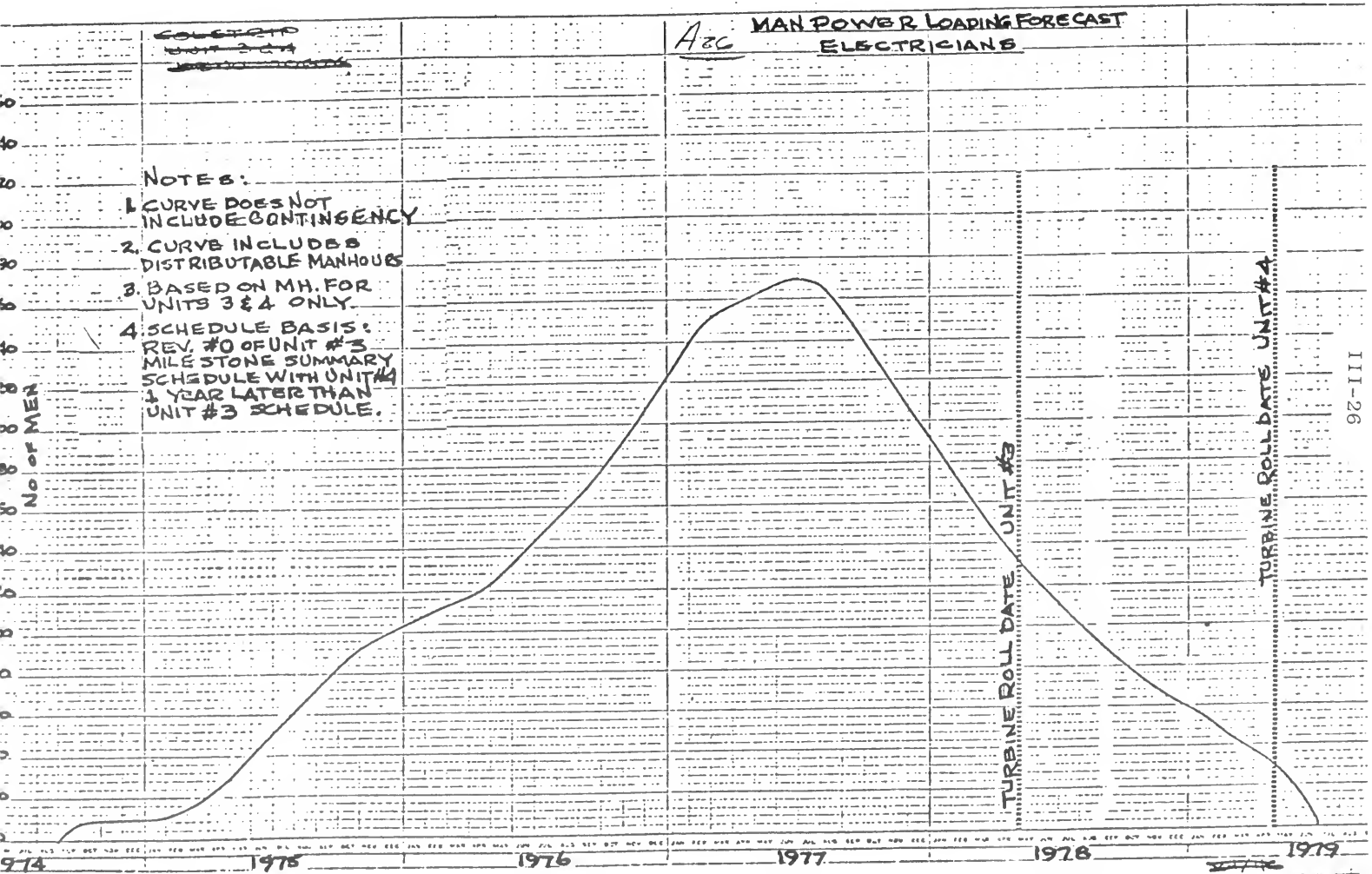

MAN POWER LOADING FORECAST
ELECTRICIANS
NOTES:
1. CURVE DOES NOT INCLUDE CONTINGENCY
2. CURVE INCLUDES DISTRIBUTABLE MANHOURS
3. BASED ON MH. FOR UNITS 3 & 4 ONLY.
4. SCHEDULE BASIS: REV. #0 OF UNIT #3 MILESTONE SUMMARY SCHEDULE WITH UNIT #4 1 YEAR LATER THAN UNIT #3 SCHEDULE.
No. of MEN
TURBINE ROLL DATE UNIT #3
TURBINE ROLL DATE UNIT #4
1974
1975
1976
1977
1978
1979

Figure III-6

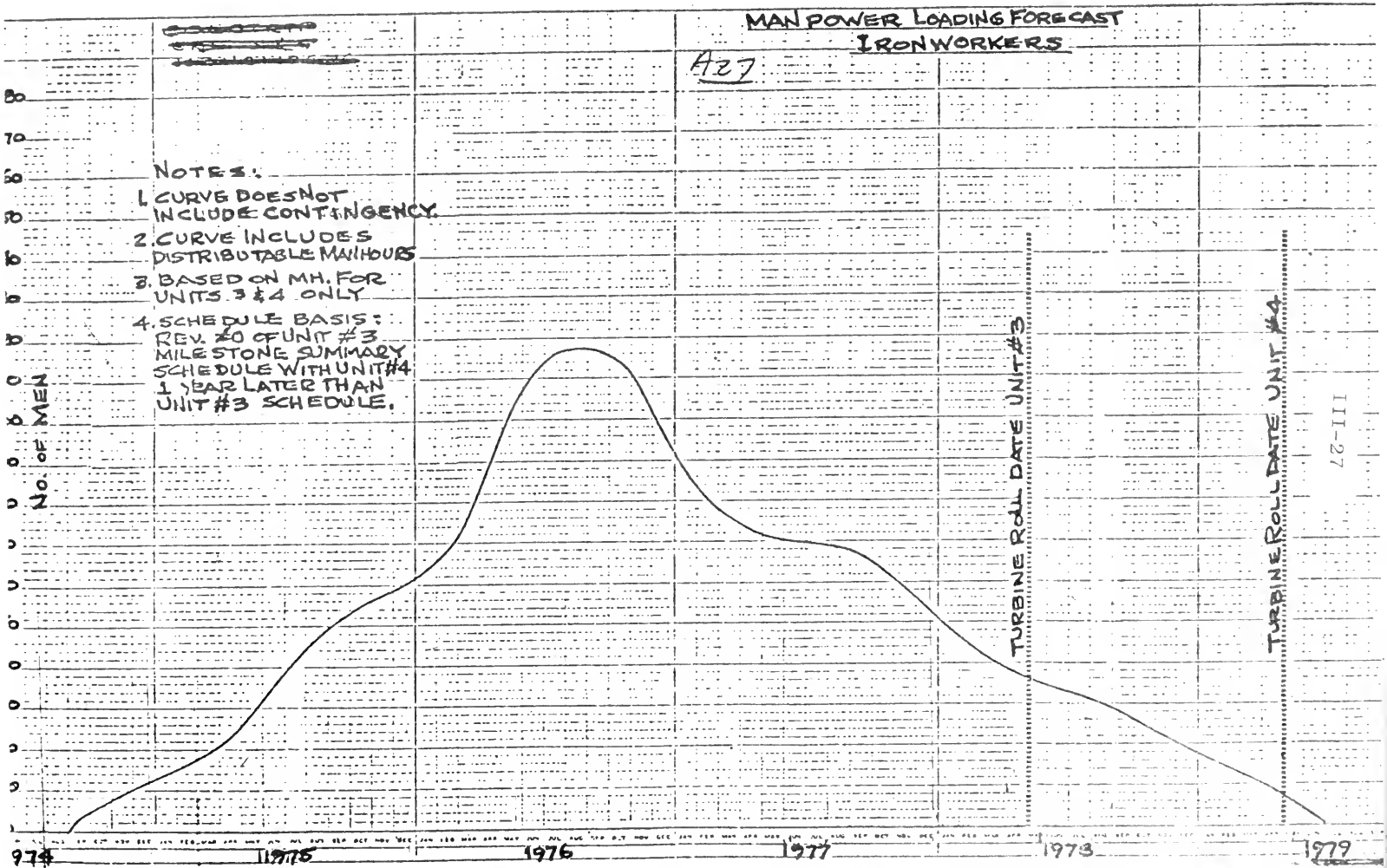

MAN POWER LOADING FORECAST
IRONWORKERS
A27
NOTES:
1. CURVE DOES NOT INCLUDE CONTINGENCY.
2. CURVE INCLUDES DISTRIBUTABLE MANHOURS
3. BASED ON MH. FOR UNITS 3 & 4 ONLY
4. SCHEDULE BASIS: REV. 20 OF UNIT #3 MILESTONE SUMMARY SCHEDULE WITH UNIT#4 1 YEAR LATER THAN UNIT #3 SCHEDULE.
No. OF MEN
TURBINE ROLL DATE UNIT #3
TURBINE ROLL DATE UNIT #4
1974
1975
1976
1977
1978
1979

Figure III-7

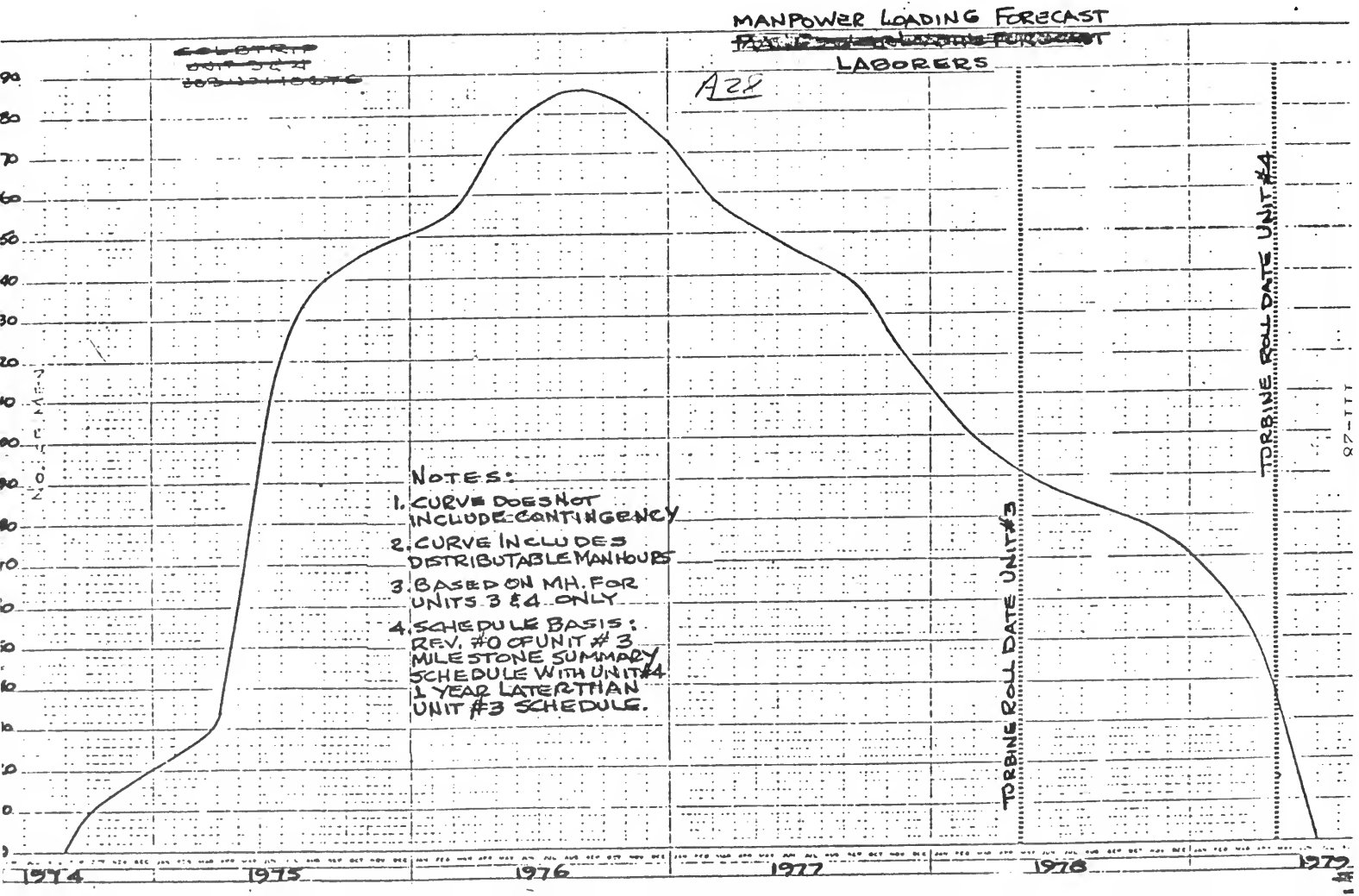
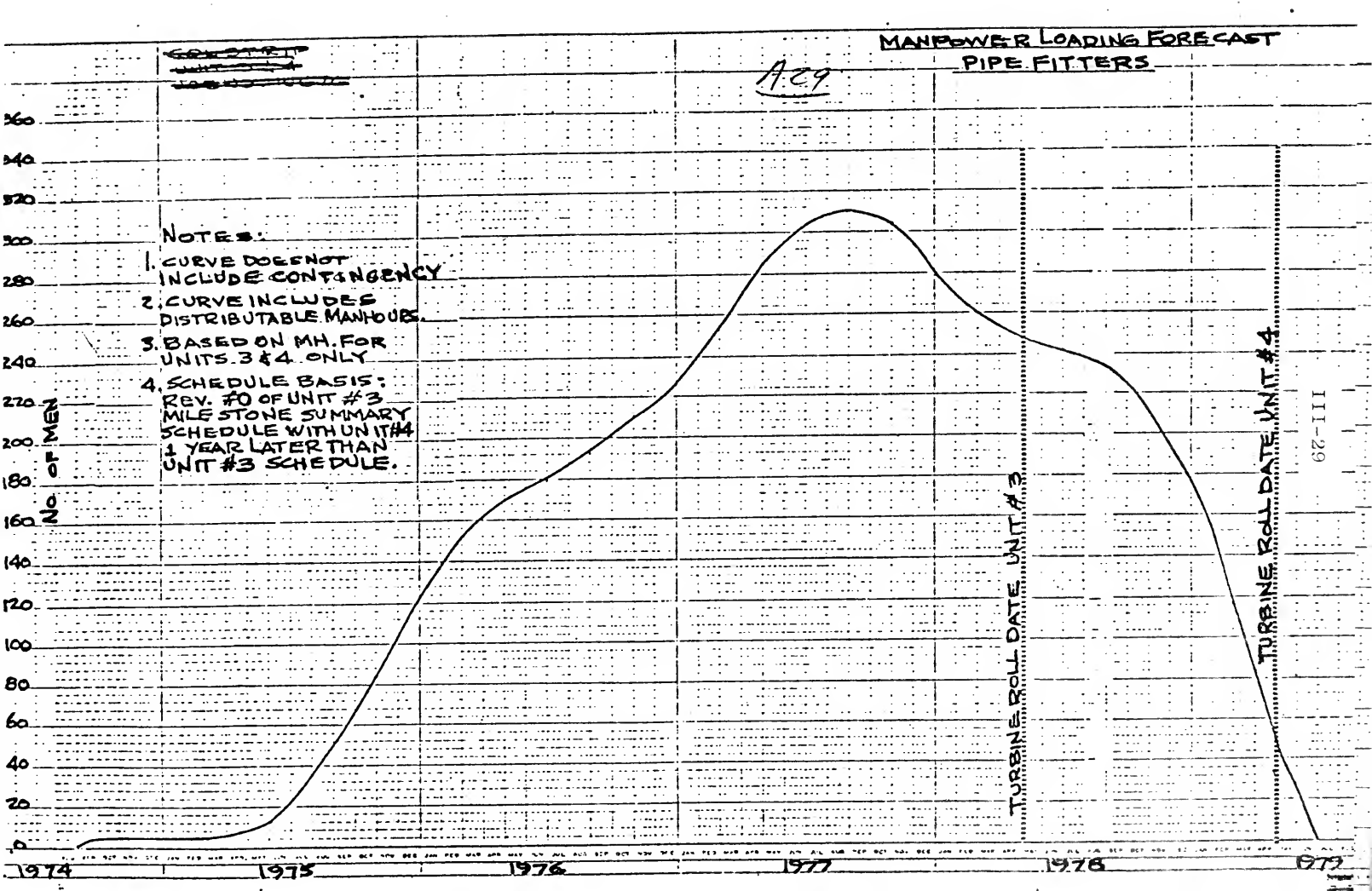

MANPOWER LOADING FORECAST
LABORERS
A22
TORBINE ROLL DATE UNIT #4
TORBINE ROLL DATE UNIT #3
NOTES:
1. CURVE DOES NOT INCLUDE CONTINGENCY
2. CURVE INCLUDES DISTRIBUTABLE MANHOURS
3. BASED ON MH. FOR UNITS 3 & 4 ONLY
4. SCHEDULE BASIS: REV. #0 OF UNIT #3 MILESTONE SUMMARY SCHEDULE WITH UNIT #4 1 YEAR LATER THAN UNIT #3 SCHEDULE.
1974
1975
1976
1977
1978
1979

Figure III-8


MANPOWER LOADING FORECAST
PIPE FITTERS
A-29
NOTES:
1. CURVE DOES NOT INCLUDE CONTINGENCY
2. CURVE INCLUDES DISTRIBUTABLE MANHOURS.
3. BASED ON MH. FOR UNITS 3 & 4 ONLY
4. SCHEDULE BASIS: REV. #0 OF UNIT #3 MILE STONE SUMMARY SCHEDULE WITH UNIT #4 1 YEAR LATER THAN UNIT #3 SCHEDULE.
No OF MEN
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
1974
1975
1976
1977
1978
1979
TURBINE ROLL DATE UNIT #3
TURBINE ROLL DATE UNIT #4

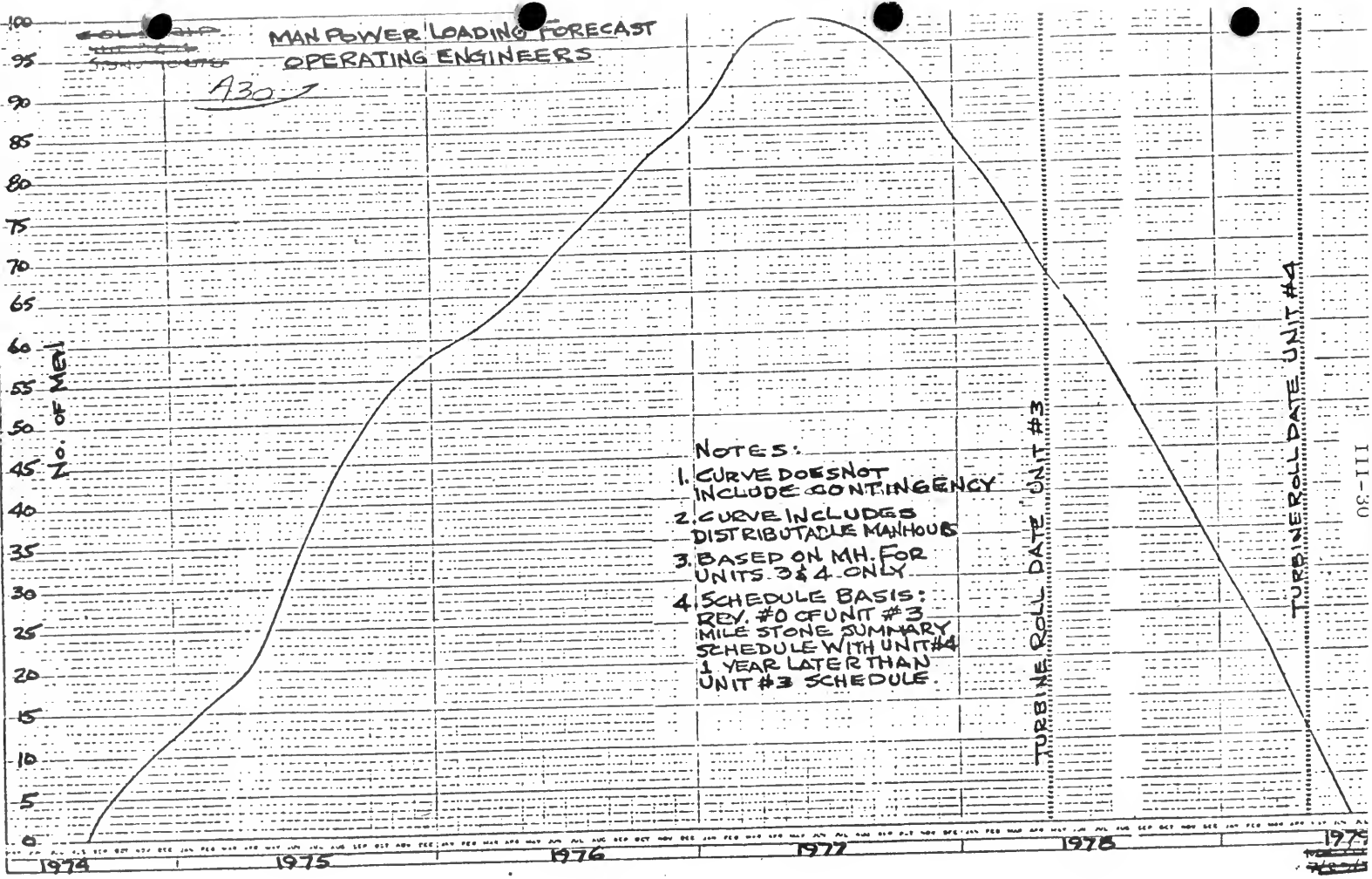

MAN POWER LOADING FORECAST
OPERATING ENGINEERS
A30
NO. OF MEN
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1974
1975
1976
1977
1978
1979
NOTES:
1. CURVE DOES NOT INCLUDE CONTINGENCY
2. CURVE INCLUDES DISTRIBUTABLE MANHOURS
3. BASED ON MH. FOR UNITS 3 & 4 ONLY
4. SCHEDULE BASIS: REV. #0 OF UNIT #3 MILE STONE SUMMARY SCHEDULE WITH UNIT #4 1 YEAR LATER THAN UNIT #3 SCHEDULE.
TURBINE ROLL DATE UNIT #3
TURBINE ROLL DATE UNIT #4

Figure III-9

Figure III-10

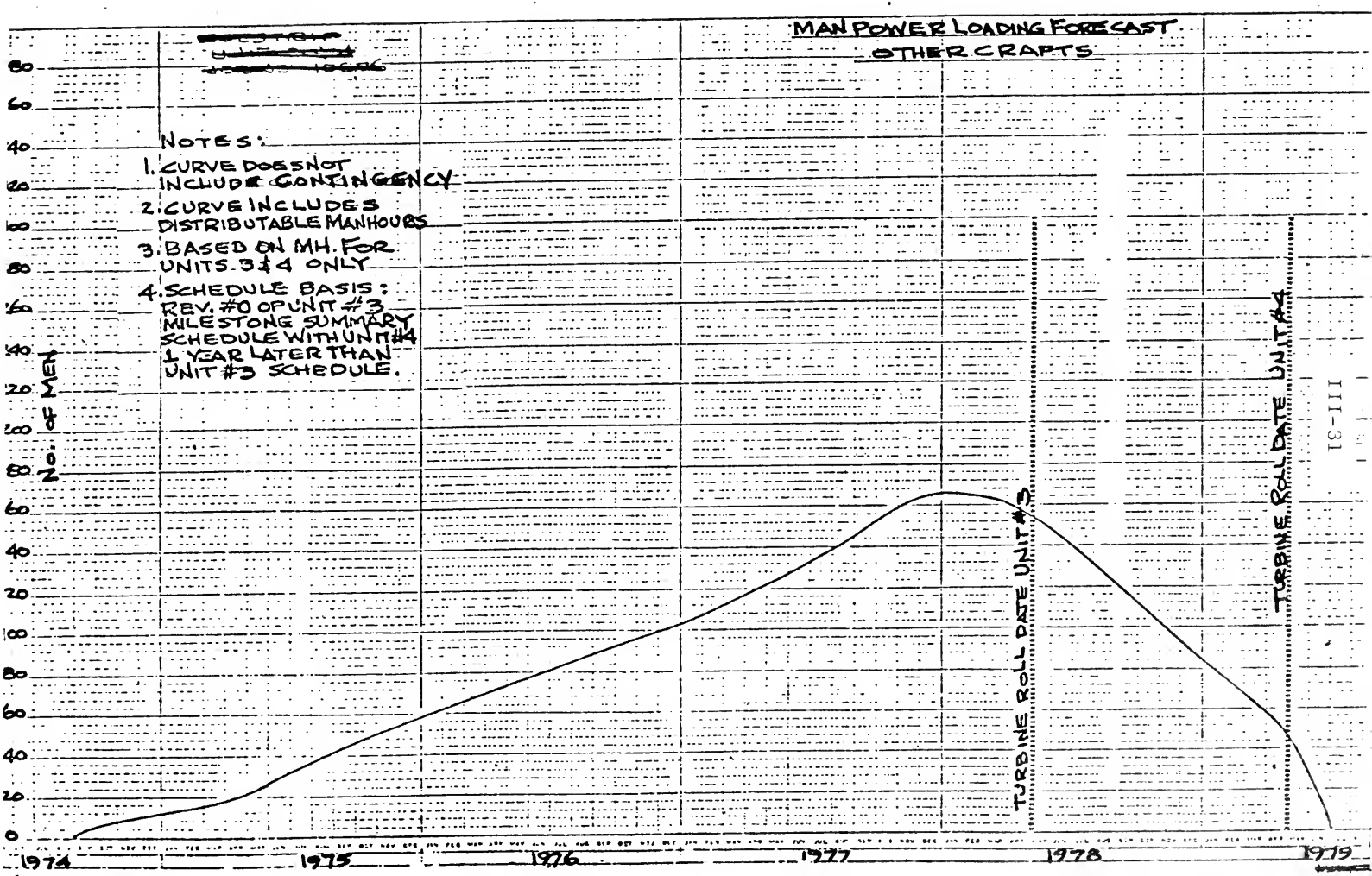
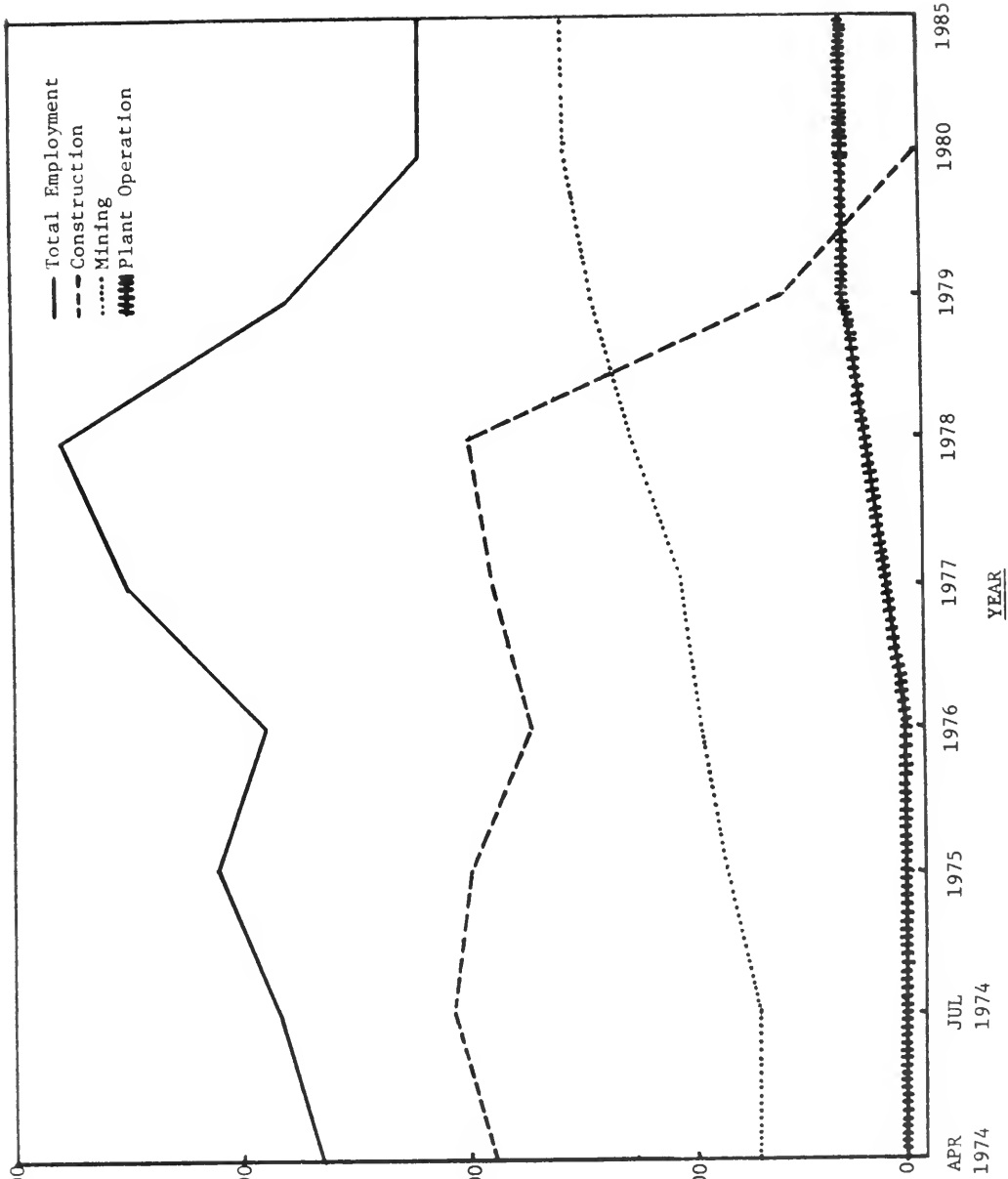


Figure III-11

EMPLOYMENT PROJECTIONS FOR THE THREE MINING PROJECTS



CHAPTER IV

PERSONAL INCOME

If, as the preceding chapter points out, coal development occurs in some fashion like the scenarios, there would be substantial employment effects. And with increases in employment come increases in personal income.

Table IV-1 details population, employment, personal income and earnings by industry for Montana for 1950, 1969 and 1971.

Table IV-1 */

	1950	1969	1971
Population, midyear	593,000	693,000	700,000
Per capita income (1967$)	2,239	2,932	3,087
Per capita income relative (U.S.=100)	108	85	87
Total employment	220,468	254,088	--
Employment/population ratio	.37	.36	--
	In Thousands of 1967 Dollars		
Total personal income	1,327,879	2,034,876	2,189,364
Total earnings	1,140,353	1,579,176	1,675,236
Agriculture, forestry and fisheries	359,835	252,543	252,733
Mining	61,301	53,508	47,887
Metal	--	29,214	28,376
Coal	--	979	1,928
Crude petroleum & natural gas	--	17,513	11,628
Nonmetallic, except fuels	--	5,804	5,954
Contract construction	71,636	100,269	112,434

*/ From Survey of Current Business.

Table IV-1 Cont'd.

	In Thousands of 1967 Dollars		
	1950	1969	1971
Manufacturing	90,492	176,677	179,928
Food & kindred products	--	28,181	28,519
Textile mill products	--	(D)	(D)
Apparel and other fabric products	--	210	236
Lumber products & furniture	--	62,514	63,460
Paper and allied products	--	(D)	(D)
Printing and publishing	--	11,357	11,582
Chemicals and allied products	--	3,134	3,408
Petroleum refining	--	12,846	15,069
Primary metals	--	36,528	31,821
Fabricated metals & ordnance	--	(D)	(D)
Machinery, excluding electrical	--	1,547	1,412
Electrical machinery & supplies	--	(D)	(D)
Motor vehicles & equipment	--	(L)	(L)
Trans. equip., excl. mtr. vehs.	--	794	1,578
Other manufacturing	--	(D)	(D)
Trans. comm., & public utilities	116,507	143,317	152,396
Wholesale and retail trade	198,618	262,428	278,340
Finance, insurance & real estate	28,106	60,074	63,383
Services	95,681	204,930	222,301
Government	118,178	325,427	365,823
Federal civilian government	42,962	88,754	101,294
State and local government	60,819	186,696	213,708
Federal military	14,372	49,974	50,829

Table IV-2: Poverty Status of Families and Persons 1959 and 1969, Percent Below the Poverty Level */

	Persons		Families	
	1959	1969	1959	1969
Montana	19.5%	13.6%	16.2%	10.4%
U.S.	22.1	13.7	18.4	10.7

*/ From U.S. Statistical Abstract.

Table VI-2 Cont'd.

	Persons		Families	
	1959	1969	1959	1969
Idaho	18.7%	13.2%	16.4%	10.9%
Wyoming	15.6	11.7	13.1	9.3
Utah	15.4	11.4	13.3	9.1
Colorado	18.3	12.3	14.5	9.1
North Dakota	27.1	15.7	23.1	12.4
South Dakota	30.1	18.7	26.8	14.8

Table IV-2 compares Montana with surrounding states and the nation for percentage of persons and families below poverty level income. We are closely below the nation, and generally in the middle of nearby states.

Total income effects of the scenarios have not been estimated. Recent studies with income estimates are discussed, however.

As with population and employment, the space, time and size distribution of coal-related development will strongly influence the resultant effects upon personal income in Montana. There are several major avenues for the income effects to reach the Montana economy. First is wages and salaries of direct employees. Second is wages and salaries of secondary and tertiary employment. Then comes returns to other factors of production -- coal royalties, surface leases and returns to coal-related capital. The essential factor in this latter category is the pattern of non-labor factor ownership.

In 1973, state coal royalty collections were $474,915, with the federal government collecting $178,816, for a total of $653,731. This constitutes 22 percent of all royalty payments in 1973. Thus, approximately 88 percent of 1973 royalties went to non-governmental entities. Although property taxes must be paid on royalties by those receiving them, their identity is confidential. Therefore, it is virtually impossible to identify the geographic distribution and socio-economic characteristics of the royalty recipients. The total of approximately $2.25 million is not an insignificant addition to incomes -- corporate and personal.

Regarding royalties as a factor in income determination on Indian reservations, it was July 1974 that coal production began on Indian coal. Westmoreland's contract with the Crows is expected to produce a minimum of $5.6 million in royalties through 1980.

In 1973, royalty payments averaged 27.4¢ per ton. This compares with 17.5¢ per ton on state coal, 8.2¢ per ton at Knife River, and an average 41.4¢ per ton on all Decker coal production.

In addition to royalties, arrangements must be made with the surface owner to buy or lease his surface rights before mining can begin.

Since no data are available on this aspect, it is difficult to even generalize as to this as a factor in income determination. Because the number of buyers and sellers appears to be large, and information is scarce, there is probably great variation in prices being paid for surface rights.

Table IV-3, from Polzin, looks at personal income in his economic impact areas, with and without coal development.

In the Colstrip 3 and 4 study, the Montana Department of Natural Resources looked at Rosebud County under three scenarios, as explained in Table III-12.

Table IV-4, from that study, plots several economic measures for Rosebud County by year from 1972 to 1981 and beyond.

Figures IV-1 and IV-2 look at Rosebud County per capita personal income.

As pointed out in Chapter VI, there can be substantial increases in trade as a result of coal development. Purchases by firms and individuals follow varying patterns. Major determinants of trade patterns are: distribution and income of workers; availability and quality of shopping in local impact areas and regional trading centers; availability and competitiveness of industrial suppliers, etc.

As far as impact on Indians and Indian incomes, the Billings BIA has completed a background study for the Northern Great Plains Resource Program.[21/] That study looked in detail at the Crow situation and concluded that where massive coal development occurs, as expected with Crow coal, there is expected to be significant

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21/ "Indians in the Northern Great Plains, Anticipated Socio-Economic Impacts of Coal Development," USDI, BIA, Billings.

Table IV-3

Personal Income and Per Capita Income in the Economic Impact Areas
with and without Coal Development
1970 and Projected 1980 and 1985

(In 1970 Dollars)

	1970	Projected 1980	Projected 1985
Total personal income			
Three-county impact area[a]			
With no coal development	$ 60,951,000	$ NA	$ NA
With coal development			
Alternative I -- no gasification	60,951,000	115,848,000	140,884,000
Alternative II -- with gasification	60,951,000	135,721,000	184,810,000
Seven-county impact area[b]			
With no coal development	441,527,000	624,665,000	741,048,000
With coal development			
Alternative I -- no gasification	441,527,000	699,175,000	837,058,000
Alternative II -- with gasification	441,527,000	731,598,000	908,725,000
Per capita personal income			
Three-county impact area[a]			
With no coal development	3,200	NA	NA
Percentage of United States	*81*	--	--
With coal development			
Alternative I -- no gasification	3,200	4,900	5,600
Percentage of United States	*81*	*91*	*91*
Alternative II -- with gasification	3,200	5,200	6,100
Percentage of United States	*81*	*97*	*99*
Seven-county impact area[b]			
With no coal development	3,600	4,800	5,600
Percentage of United States	*91*	*89*	*91*
With coal development			
Alternative I -- no gasification	3,600	5,200	5,850
Percentage of United States	*91*	*97*	*96*
Alternative II - with gasification	3,600	5,250	5,950
Percentage of United States	*91*	*97*	*96*

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economics Information System, unpublished data (Washington, D.C., 1973); and *Idem*, Regional Analysis Projection System, OBERS Projections, unpublished data (Washington, D.C., November 1973). The total personal income projections under Alternatives I and II and all the net migration projections were developed by the University of Montana, Bureau of Business and Economic Research (Missoula, Montana).

NA denotes not available.

[a]Big Horn, Powder River, and Rosebud counties.

[b]Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure, and Yellowstone counties.

Table IV-4

Earnings, Personal Income, Employment, and Population 1972 to 1981, and Employment and Population Differences Beyond 1981, Rosebud County, Alternative Scenarios

	1972	1973	1974	1975	1976
Scenario I:					
Earnings (000$)	19,412	28,298	43,133	40,835	37,164
Personal Income (000$)	24,191	34,762	52,984	50,161	45,633
Employment	2,909	3,333	4,611	4,604	4,437
Population	6,400	7,766	10,744	10,727	10,338
Scenario II:					
Earnings (000$)	19,412	28,298	43,133	40,835	37,164
Personal Income (000$)	24,191	34,762	52,984	50,161	45,633
Employment	2,909	3,333	4,611	4,604	4,437
Population	6,400	7,766	10,744	10,727	10,338
Scenario III:					
Earnings (000$)	19,412	28,298	43,133	47,374	57,633
Personal Income (000$)	24,191	34,762	52,984	58,194	70,797
Employment	2,909	3,333	4,611	5,112	6,114
Population	6,400	7,766	10,744	11,911	14,246

Table IV-4

Earnings, Personal Income, Employment, and Population 1972 to 1981, and Employment and Population Differences Beyond 1981, Rosebud County, Alternative Scenarios

	1977	1978	1979	1980	1981	Beyond* 1981
Scenario I:						
Earnings (000$)	35,517	36,344	37,485	36,663	56,778	
Personal Income (000$)	43,629	44,645	46,046	45,037	45,178	
Employment	4,347	4,388	4,464	4,392	4,376	Base
Population	10,129	10,224	10,401	10,233	10,196	Base
Scenario II:						
Earnings (000$)	35,517	37,225	40,262	40,576	40,966	
Personal Income (000$)	43,629	45,728	49,458	49,844	50,322	
Employment	4,347	4,455	4,685	4,725	4,757	+ 477
Population	10,129	10,380	10,901	11,009	11,084	+1,112
Scenario III:						
Earnings (000$)	64,830	56,458	49,771	45,935	45,251	
Personal Income (000$)	79,638	69,353	61,138	56,426	55,586	
Employment	6,932	6,489	5,967	5,577	5,417	+ 759
Population	16,152	15,119	13,903	12,994	12,622	+1,768

*Differences represent population and employment differences between three scenarios

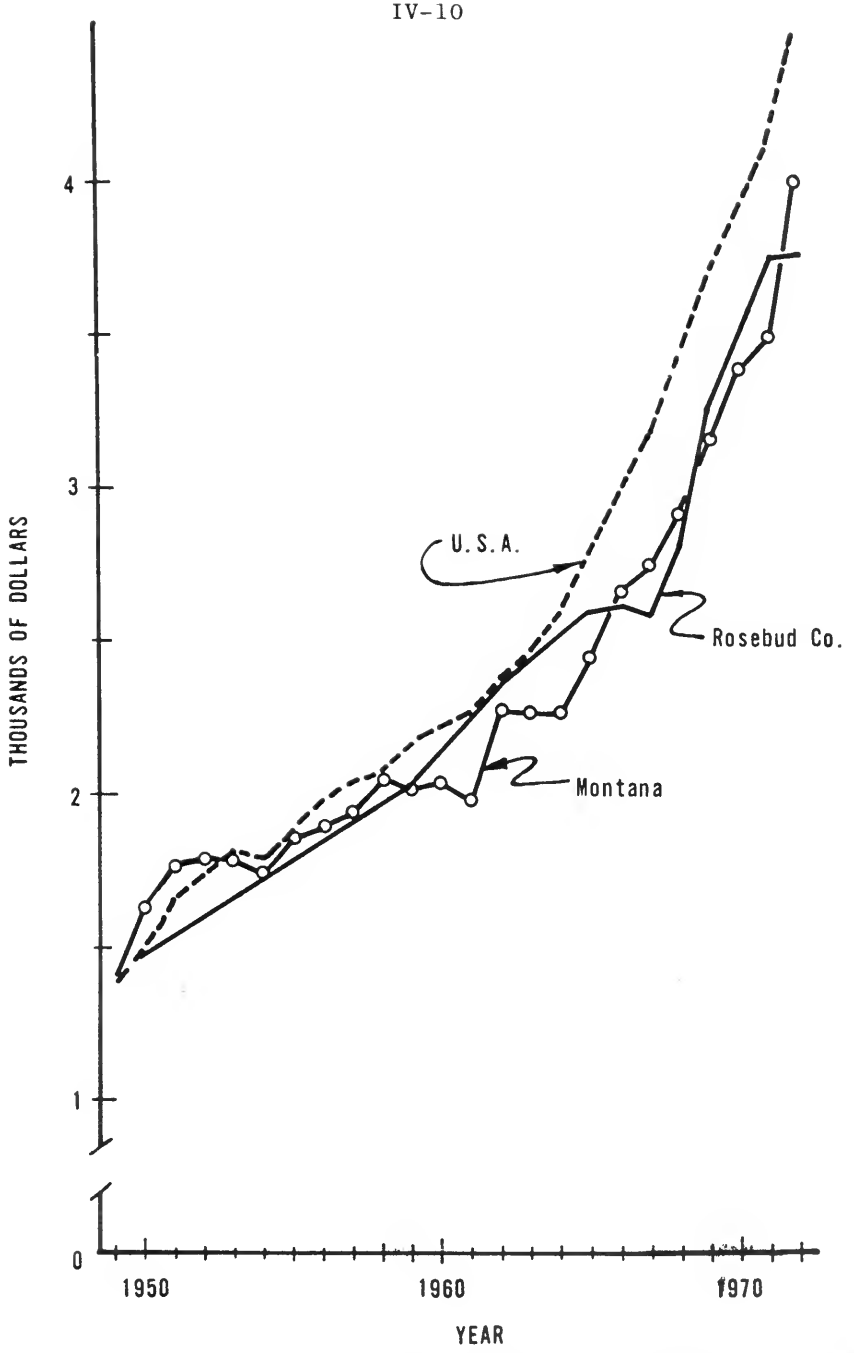

Figure IV-1

Per Capita Personal Income; Rosebud County, Montana, and the U.S.A., 1949-1972, in Current Dollars

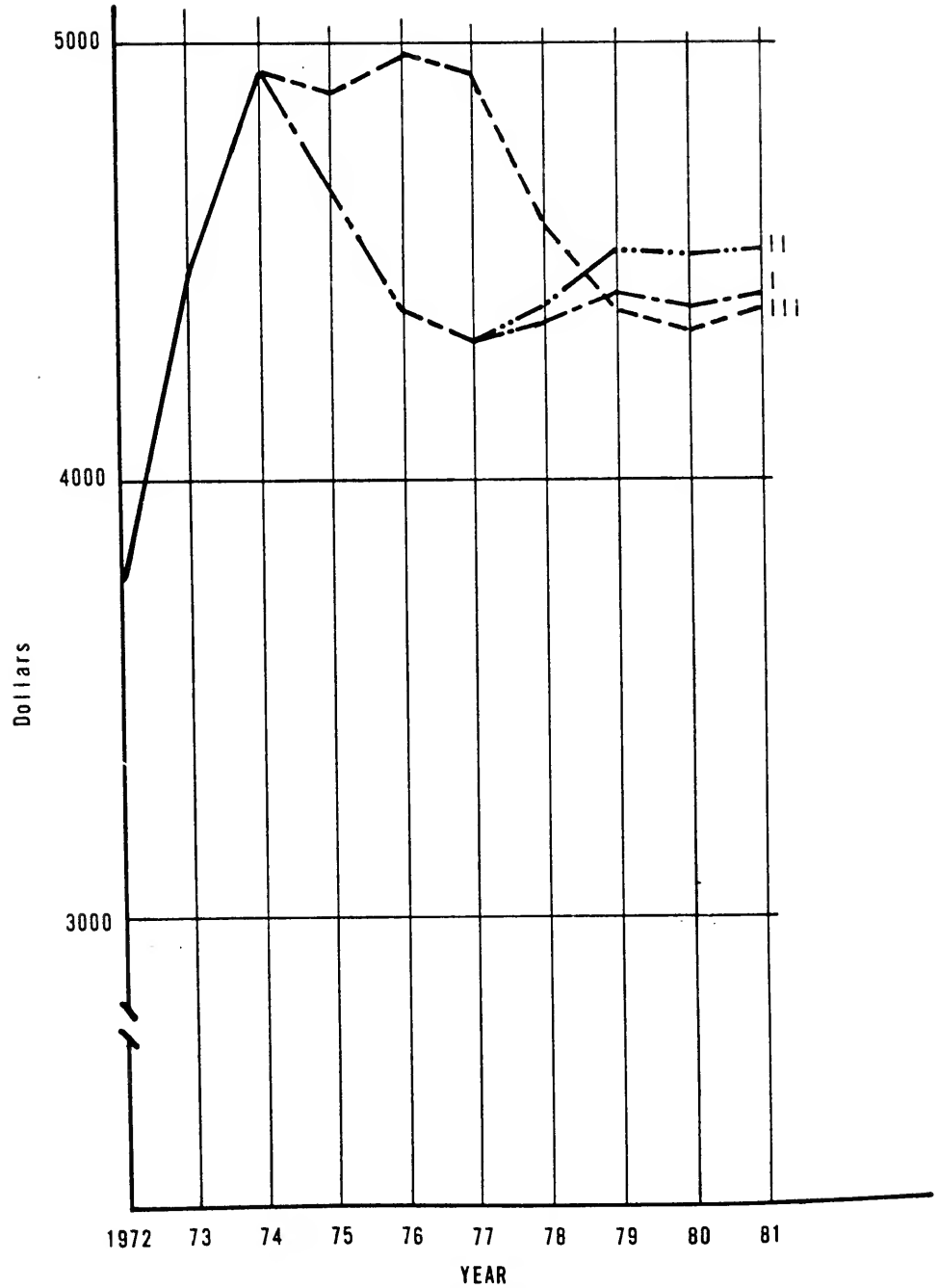

Figure IV-2

Per Capita Personal Income, Rosebud County
1973-1981 in Current Dollars. Scenarios I, II and III

socio-economic change including: (1) increased employment opportunities; (2) significantly increased incomes to Indian people; (3) substantial increase in population levels; (4) increased need for social services; and (5) substantial changes in community institutions and values.

CHAPTER V.

TAX AND ROYALTY REVENUES

The coal mining industry is affected by the following four major taxes: Net Proceeds Tax, Resource Indemnity Trust Tax, Strip Coal Mines License Tax and a Corporate License Tax. All mineral production, including oil and gas is subject to the Net Proceeds Tax, while the Strip Coal Mines Tax pertains exclusively to coal. All corporations are subject to Corporate License Taxes, and the Resource Indemnity Trust Act includes all "nonrenewable resource" extracting firms. All of these taxes are imposed and collected by the state except the Net Proceeds Tax, which is collected at the county level, but imposed by authority granted by state statute. These taxes represent the bulk of taxes paid by strip coal mine operators to the state. However, other property taxes paid by the coal industry, related business license taxes, and gross vehicle weight taxes yield added revenue.

Net Proceeds Tax -- tax on net proceeds of mines. This tax is imposed on the valuation placed on the net proceeds of the mining firm. The law provides that the net proceeds valuation shall be taxed as Class 1 property. This property is taxed on a basis of 100 percent "true and full value." It then becomes subject to state and county millage levied against property at exactly its assessed value.

Royalties paid may be deducted as a cost of extracting by the producer, but he must then submit a list of those to whom such

royalties were paid to the Department of Revenue. The Department of Revenue then sends an assessment list to the county assessor of the county in which the mines are located, and such royalties become taxable as Class 1 property of the payees on the tax rolls at full cash value. In this process, royalties become an expense of the coal producer and taxable property of the payee.

Resource Indemnity Trust Account Tax -- tax on value of product extracted. The act creating the Resource Indemnity Trust Account was passed by the 1973 legislature and first affected taxes in the calendar year 1973. The tax is imposed at the ratio of one-half percent of the gross mine mouth or wellhead value of all nonrenewable mineral resources, including coal, oil and gas. The monies are deposited in a special earmarked account in the Trust and Legacy Fund. The revenues and interest earned will remain untouched until $10 million are accumulated. At that time, the legislature may appropriate the annual interest to areas subject to social, economic or environmental impacts of mineral development. After the fund reaches $100 million, both the interest and each year's revenues may be appropriated.

Strip Coal Mines License Tax -- applicable to strip coal mine operators. The first 5,000 pounds of coal is exempt, as is coal used by the miner for mining operations. The tax per ton depends on BTU content as follows:

BTU Range Per Pound of Coal	Tax Per Ton of Coal
7,000 and below	$.12
7,001 - 8,000	.22
8,001 - 9,000	.34
9,001 and above	.40

The general fund of the county from which the coal is mined receives three cents per ton; the balance goes to the state general fund. This is the most significant of the taxes levied on coal production.

Corporation License Tax -- tax on corporate net income. The Corporation License Tax is imposed on all corporations for the privilege of doing business in the State of Montana. The 1973 legislature set this tax at 6-3/4 percent of net income derived in Montana, with a minimum tax of $50. This is paid as an annual fee to the state treasurer, and several state funds are the beneficiaries: 64 percent goes to the general fund, 25 percent to the school equalization fund and 11 percent to the long-range building program, or to the general fund if the building program has sufficient current funding already. Corporate net income is derived basically as allowed in federal taxation, that being gross income less allowable corporate deductions to derive taxable corporate income.

Historic Tax Revenues

Table V-1 presents a mine-by-mine summary of data used in calculation of net proceeds and was compiled by the Montana Department of Revenue. All of the major operations listed are strip mines. The Western Energy and Peabody Coal Companies operate strip mines in Rosebud County. Westmoreland Resources and the Decker Coal Company strip mine in Big Horn County. Knife River Coal's production is from Richland County. Consolidation Coal's 1971 production was from a strip mine test pit in the Bull Mountains of Musselshell County. With the exception of Westmoreland, the mines lumped in the "others" category are all small family-operated mines producing for local markets. The reported small mine production is predominantly from underground operations.

Table V-2 summarizes by year a number of Montana taxes paid by coal mining companies. Taxes on royalties are paid by those receiving royalties. Because of certain confidentiality provisions in Montana tax codes, MEAC cannot report corporate license tax or resource indemnity trust tax proceeds on a company-by-company basis.

Aggregating the data, in 1973 the Montana coal mining industry paid $109,203.10 to the newly created Resource Indemnity Trust Fund. In 1969, 1970, 1971 and 1972, the industry paid $26,202, $35,484, $120,905 and $59,931, respectively, in corporate license taxes.

Table V-1: Net Proceeds Tax Data

Cal. Year	Production (Tons)	Gross Price Per Ton	Gross Value	Gross Price Per Mil. BTU's	Production Costs (Less Royalties)	Production Costs Per Ton	Royalties	Royalties Per Ton	Net Proceeds Exclud. Royalty	Net Proceeds Per Ton	Net Proceeds Per Mil. BTU's
WESTERN ENERGY COMPANY											
1973	4,253,781	$2.011	$8,553,345	$.116	6,351,279	$1.493	$580,023	$.136	$1,622,043	$.381	$.0[illegible]
1972	5,500,775	1.792	9,856,205	.103	5,863,478	1.066	738,854	.134	3,253,873	.592	.0[illegible]
1971	5,161,390	1.743	8,996,564	.100	4,633,336	.898	696,788	.135	3,666,440	.710	.0[illegible]
1970	1,657,737	1.694	2,808,079	.098	1,399,586	.844	223,794	.135	1,184,699	.715	.0412
1969	521,449	1.811	944,470	.104	449,230	.862	67,828	.130	427,411	.820	.0[illegible]
1968	150,416	1.800	270,748	.104	283,686	1.886	18,050	.120			
PEABODY COAL COMPANY											
1973	1,971,643	2.1525	4,244,484	.125	3,449,633	1.750	603,663	.306	191,188	.097	.0[illegible]
1972	1,601,179	1.9703	3,154,795	.115	2,360,650	1.474	639,465	.399	154,680	.097	.0[illegible]
1971	1,495,222	1.8857	2,819,557	.110	1,767,256	1.182	585,610	.392	466,691	.312	.019[illegible]
1970	1,431,956	1.843	2,639,232	.107	1,914,411	1.337	496,940	.347	227,881	.159	.0[illegible]
1969	163,691	1.817	297,574	.106	248,237	1.516	28,660	.175	20,677	.126	.0073
DECKER COAL COMPANY											
1973	4,159,287	3.931	16,350,157	.203	7,789,805	1.873	1,723,639	.414	6,836,713	1.644	.0849
1972	792,949	3.470	2,752,674	.179	2,669,696	3.367	168,332	.212			
1971							2,679				
1970	74,856	4.6224	346,015	.239	705,439	9.424	70,963	.948			
KNIFE RIVER COAL COMPANY											
1973	312,785	2.578	806,359	.198	615,393	1.967	25,697	.082	165,268	.528	.04[illegible]
1972	320,975	2.434	781,233	.187	567,550	1.768	27,128	.085	186,566	.581	.044[illegible]
1971	325,475	2.254	733,549	.173	456,802	1.403	26,085	.080	250,662	.770	.059[illegible]
1970	321,908	2.116	681,108	.162	402,455	1.250	26,896	.084	251,758	.782	.0[illegible]
1969	306,928	2.016	618,637	.155	349,845	1.140	26,124	.085	242,668	.791	.0[illegible]
1968	329,022	1.947	640,625	.149	313,710	.953	26,504	.081	300,411	.913	.07[illegible]

Table V-1 Cont'd.

Cal. Year	Production (Tons)	Gross Price Per Ton	Gross Value	Gross Price Per Mil. BTU's	Production Costs (Less Royalties)	Production Costs Per Ton	Royalties	Royalties Per Ton	Net Proceeds Exclud. Royalty	Net Proceeds Per Ton	Net Proceeds Per Mil. BTU's
KNIFE RIVER COAL COMPANY Cont'd.											
1967	326,757	$1.948	$636,563	$.149	391,756	$1.199	$27,646	$.085	$217,162	$.665	$.0510
1966	325,348	1.940	631,265	.149	372,139	1.144	24,521	.075	234,605	.721	.0553
CONSOLIDATION COAL COMPANY											
1971	38,679	3,975	153,737		214,199	5.538	3,377	.087			

OTHERS (Square Deal, Westmoreland - no production in subject tax years, William Nies, Victor and Jack Carlson, Brenteson, Stephenson, Schoonover, Rosebud Coal Sales)

	Total	Avg.	Total	Total	Avg.	Total		Total
1973	23,917	11.04	264,117	303,712	12.70	6,055	.252	3,750
1972	27,769	10.12	281,011	281,077	10.12	8,566	.308	5,412
1971	50,760	5.83	295,682	324,368	6.39	6,843	.135	14,193
1970	25,321	10.17	257,411	253,281	10.00	6,796	.268	1,212
1969	26,202	9.61	251,823	251,844	9.61	6,662	.254	
1968	27,687	8.88	245,793	246,178	8.89	6,021	.217	312
1967	29,204	8.33	243,170	249,322	8.54	4,683	.160	165

Table V-2: Select Coal Taxes Paid
on Calendar Year Production

Calendar Year	Real & Pers. Property Tax	Net Proceeds	Strip Coal Mines License Tax	Taxes on Royalties
WESTERN ENERGY COMPANY				
1973	73,285.60	211,449.53 */	837,469.99	58,295.13
1972	52,180.00	438,101.46	419,154.48	93,166.20
1971	51,191.74	418,780.78	327,476.77	79,587.08
1970	32,090.58	147,471.33	76,214.10	27,857.93
1969	12,224.47	58,854.49	21,639.89	9,339.95
PEABODY COAL COMPANY				
1973	41,294.95	24,923.27 */	397,103.60	78,693.51
1972	21,590.16	20,826.12	106,691.34	86,097.57
1971	23,427.22	53,305.45	92,238.42	66,888.37
1970	22,329.67	28,366.63	69,097.80	61,859.09
1969	11,716.16	2,847.22	5,684.25	3,938.22
DECKER COAL COMPANY				
1973	52,039.64	674,510.10 */	1,181,354.04	101,646.04
1972	51,306.79		78,794.90	7,975.02
1971				
1970			1,242.79	
KNIFE RIVER COAL COMPANY				
1973	12,120.18	23,425.09 */	25,309.14	2,683.04
1972	11,703.19	29,768.47	14,352.61	1,877.65

*/ Estimated on an eight-year average mill levy.

Table V-2 Cont'd.

Calendar Year	Real & Pers. Property Tax	Net Proceeds	Strip Coal Mines License Tax	Taxes on Royalties
KNIFE RIVER COAL COMPANY CONT'D.				
1971	10,848.32	39,013.03	12,516.97	3,507.03
1970	11,882.23	35,419.83	11,466.70	1,999.54
1969	10,754.98	36,300.71	10,284.93	2,366.10
CONSOLIDATION COAL COMPANY				
1971			2,981.00	451.89
OTHERS				
1973	478.00	491.93 */	843.82	598.61
1972	555.00	716.12	324.10	675.10
1971	1,015.00	1,906.83	2.67	857.56
1970	506.00	172.75		436.57
1969	524.00			210.17

*/ Estimated on an eight-year average mill levy.

Projected Tax Revenues

Table V-3 projects state and county revenues from the Strip Coal Mines License Tax on a fiscal year (July 1 - June 30) basis. It is based on MEAC coal production projections (Table II-11) and is calculated by averaging the projected production of the two calendar years in which given fiscal years fall. Fiscal Year 1975 calculations for Westmoreland Resources are an exception in that their production commenced in July 1974. All of Westmoreland's 1974 production is included in the Fiscal Year 1975 projection.

Given solid, conservative production projections and assuming that the staggered-scale tax rates will continue to be based on BTU content, projection of Strip Coal Mines License Tax revenues is straightforward. The other major taxes levied on coal production, however, are based on an adjusted gross value of the coal sold (Resource Indemnity Trust) or complex determinations of the net value of the coal produced (Corporate License and Net Proceeds Taxes).

As indicated by Table V-1, the gross per ton value of coal produced by each Montana strip mine has been increasing every year. Recent coal sales contracts indicate the trend is accelerating rapidly. Decker Coal recently negotiated a coal sales contract with an Austin, Texas, utility that calls for shipments

Table V-3: Projected Revenues, Montana Strip Coal Mine License Tax, By Fiscal Year

Company	FY 1975 Tons	FY 1975 Amount	FY 1976 Tons	FY 1976 Amount	FY 1977 Tons	FY 1977 Amount
Knife River	320,000	$ 38,400	320,000	$ 38,400	320,000	$ 38,400
Western Energy	4,032,500	1,371,050	7,830,000	2,662,200	11,965,000	4,068,100
Peabody	2,850,000	969,000	3,000,000	1,020,000	3,000,000	1,020,000
Westmoreland	3,500,000	1,190,000	4,000,000	1,360,000	5,250,000	1,785,000
Decker	7,625,000	3,050,000	9,575,000	3,830,000	10,900,000	4,360,000
FY Totals	18,327,500	$6,618,450	24,725,000	$8,910,600	31,435,000	$11,271,500
To Counties		$ 549,825		$ 741,750		$ 943,050
To State		$6,068,625		$8,168,850		$10,328,450

Company	FY 1978 Tons	FY 1978 Amount	FY 1979 Tons	FY 1979 Amount	FY 1980 Tons	FY 1980 Amount
Knife River	320,000	$ 38,400	320,000	$ 38,400	320,000	$ 38,400
Western Energy	14,200,000	4,828,000	16,300,000	5,542,000	18,400,000	6,256,000
Peabody	3,000,000	1,020,000	3,000,000	1,020,000	3,000,000	1,020,000
Westmoreland	6,500,000	2,210,000	6,500,000	2,210,000	6,500,000	2,210,000
Decker	12,700,000	5,080,000	13,300,000	5,320,000	13,000,000	5,200,000
FY Totals	36,720,000	$13,176,400	39,420,000	$14,130,400	41,220,000	$14,724,400
To Counties		$ 1,101,600		1,182,600		$ 1,236,600
To State		$12,074,800		$12,947,800		$13,487,800

of two million tons per year at an initial price of approximately $7 per ton. Further, the Western Energy Company reports strong TVA interest in a 500,000 ton spot purchase at $5 per ton.

Significantly, almost all recent coal sales contracts contain an "escalator clause" that allows automatic price increases commensurate with increased taxes and production costs. According to officials of all companies strip mining coal in Montana, production costs are increasing rapidly.

Besides involving coal price, production cost and mill levy uncertainties beyond the scope of this study, projections of coal industry corporate license tax, net proceeds and resource indemnity trust tax revenues appear rather academic at this time. The 1974 Montana legislature appointed a special joint interim committee to reevaluate all forms of fossil fuel taxation and to prepare recommentations to the 1975 legislature.

Although presently not in final form, the recommendations are likely to include:

1. Replacing the Strip Coal Mines License Tax with an ad valorem severance tax levied at a yet to be determined percentage of the coal's gross mine-mouth value.

2. Replacing the Net Proceeds Tax with a property tax levied on an indeterminate percentage of gross proceeds.

MEAC recognizes evaluation of future coal-related revenues from corporate license, resource indemnity trust and net proceeds taxes (or their replacements) as a major research need. It is recommended that detailed study plans not be formulated until after adjournment of the 1975 Montana legislature.

Another major tax-related unknown involves the adequacy of county revenues from coal development. Will those revenues be adequate to meet the costs of increased services (health, sewage, education, law enforcement, welfare, etc.) that results from industrialization?

Data from Rosebud County clearly indicate that the large work force required to construct power generation facilities creates demands for county services that exceed revenues from partially completed generation plants. When the plant(s) is operational, it can be expected to be subject to greater property tax assessments. By then, however, the construction work force may be gone. Thus, under existing tax structures, county revenues peak well after the period of maximum service demand. The 1975 Montana legislature is likely to consider tax code modifications that would allow advance payment of property taxes.

Coal Royalties

State Coal Leases

The mineral and surface estates on state school trust lands have seldom been separated. For the vast majority of the 5.2 million

acres of such land, the state owns both the surface and underlying minerals including coal. As of June 30, 1974, 56,217 acres of state owned coal were under lease. (The previously referenced NGPRP estimate of 58,000 acres did not note a few state coal leases which reverted or expired.)

All proceeds from the leasing and production of state owned coal resources accrue to the permanent trust and legacy fund, state school fund account. Ninety-five percent of the annual earnings from the account is disbursed to the Superintendent of Public Instruction who prorates the monies to the 56 county school systems. Five percent of the fund's annual interest is reinvested. The state school portion of the fund totals approximately $60 million.

Coal revenues accrue to the school trust account in the following manner:

1. Leasing of state coal has been on a competitive bid basis. Minimum acceptable bonus bids are established by the Montana Bureau of Mines and Geology and the successful bidder is he who offers the highest bonus bid for the first year's lease rental. The May 26, 1970, sale netted bonus bids totalling $159,986 from coal leases on 22,835 acres. Minimum bids were met or exceeded on 41 of the 64 tracts offered.

2. Annual lease rentals on lands not in production provide the school trust with fifty cents (50¢) per acre for lease years 2, 3, 4, and 5, and one dollar ($1) per acre for the term of the lease.

Renegotiated leases (providing longer terms for lessees) provide annual rentals of one dollar ($1) per acre for the first ten years of the lease and five dollars ($5) per acre for the second ten years. Approximately $30,000 in rentals are obtained annually.

3. The lease terms provide for royalty payments of fifteen cents (15¢) per ton for lignite coal produced and seventeen and one-half cents (17½¢) per ton of subbituminous coal. During the last ten years, state coal has been mined in two locations:

The Decker Coal Company, a partnership of Peter Kewitt and Sons and Pacific Power and Light, started large-scale stripping operations in 1972. They work two state sections and other coal reserves owned by the federal government. Their total production of state coal and state royalty payments (17½¢ per ton) by year are as follows:

Year	Tonnage	Royalty
1970	74,844 (test pit)	$ 11,078.37
1971	--	--
1972	138,873	24,215.29
1973	2,736,600	474,915.03

Decker is accelerating its overall rate of production from a rate of four million tons per year to over seven million tons annually. State royalties received for the first three months of 1974 ($193,926.78 on 1,108,153 tons) reflect the increased production.

The Square Deal Coal Company, a two family partnership near Roundup, Musselshell County, has produced state coal for local domestic, school and small business consumption. For the ten-year period 1964-1973, inclusive, Square Deal produced a total of 117,792 tons. Total royalties were $20,613.67. Square Deal mined underground until 1971 when federal mine safety considerations forced a shift to strip mining. Square Deal's strippable state reserves were mined out in 1973. After backfilling, grading, top soiling, fertilizing (manure) and reseeding operations, Square Deal Coal closed down. Their market has been assumed by other small stripping operations in the Roundup area which lease coal from the Burlington Northern Railroad and/or the Bureau of Land Management.

Federal Coal Leases

Section 35 of the federal mineral leasing act of 2/25/20 provides that 37.5 percent of federal royalties received for leasable minerals (coal, oil, gas and common varieties of sand, gravel and clay) on most federal lands is to be distributed to respective state governments. County governments get 25 percent of royalties from acquired homestead lands.

Montana law directs the monies be divided equally between the state school equalization fund (state monies distributed annually to school districts) and the highway fund.

Montana received $2,949,950 pursuant to Section 35 in 1973. The Bureau of Land Management (BLM) makes semiannual payments of Section 35 funds and, for the first half of 1974, $2,483,260 was received by the state treasurer. This significant increase over 1973 revenues is almost solely attributable to increased wellhead prices for crude oil and natural gas.

Over 90 percent of the 1973 revenues are from oil and gas. According to records provided by the BLM's Billings regional office, the federal government received a total of $178,816 from Montana coal royalties in 1973. Rentals on federal leases amounted to an additional $26,695. As of January 1, 1974, a cumulative total of $2,565,442 had been collected as rentals and royalties over the life of all existing federal coal leases in Montana.

Indian Coal Leases

Two Montana Indian reservations (Crow and Northern Cheyenne) are underlain by extensive coal reserves. Recently, the Northern Cheyenne sought to cancel all existing leases on the grounds that the Bureau of Indian Affairs failed to follow a large number of regulations and laws, including NEPA, at the time of lease negotiation and execution. The Department of the Interior partially agreed to the Northern

Cheyenne request with the apparent result being tribal control of all further "go-no go" decisions regarding coal development. In October, however, the Sixth District Court ruled that individual Indian coal owners will determine the disposition of Northern Cheyenne coal, rather than the tribal council. The District Court ruling may be appealed. At present, the status of all coal leases and prospecting permits on the Northern Cheyenne Reservation is very uncertain.

The Crow Tribe has leased extensive tracts on the reservation proper as well as Indian owned coal in the so-called ceded strip along the reservation's northern border. The surface estate of the ceded strip is in private, non-Indian ownership.

Westmoreland Coal has a permit pursuant to the Montana Strip Mining and Reclamation Act and commenced production on Crow Indian ceded strip coal in July 1974. Their initial production is at the rate of four million tons per year. Westmoreland's tipple and mining facilities, however, are capable of producing and loading seven million tons per year.

The Crow Tribe just completed a lease renegotiation which significantly raised the levels of royalty payments to 40¢ per ton. The lease provides for royalty increases should the coal sales price exceed $5. Westmoreland is further obligated to produce a total of 14 million tons through 1980 or pay a penalty of 20¢ per ton on the short fall.

Private Leases

According to Action for Eastern Montana data (Table II-5), over 1 million acres of surface and/or mineral are leased, optioned or otherwise obligated to coal and energy interests in 12 Eastern Montana counties. The terms of the private coal leases vary widely, with most lease brokers and corporate land men offering different lease terms.

Surface and mineral holding of the Burlington Northern Railroad are not included in Table II-5.

CHAPTER VI

DERIVATIVE EFFECTS

Industrial Suppliers

Not all factors of production necessary for the construction and operation of a coal-related facility can be purchased in Montana. The highly specialized nature of much of the equipment and materials used in coal mining and processing and coal-based energy transportation dictates a limited number of suppliers in the nation (and the world). Examples include draglines and specialized generating equipment.

The economic impact on the state is directly related to the level of purchases within Montana. In considering the factors of production, labor has been considered elsewhere (Chapter III), as has land and water (Chapter VI). Thus, we are mainly interested in fixed capital and variable factors of production other than land on labor. This section will look at coal mining, coal processing and coal-based energy transportation in both construction and operation. Because there is extensive uncertainty as to potential but currently nonexistent (in Montana) activities such as gasification, liquefaction, coal slurry and magnetohydrodynamics, we will speculatively discuss them, but will be unable to summarize to analyze any hard data.

Because of the capital-intensive nature of all the activities we are considering here, we will look at both the construction and operation of each.

Mining - Construction

The following table, from "Cost Analyses of Model Mines for Strip Mining of Coal in the United States," lists all equipment and facilities needed to set up a five million ton per year strip mine in Montana. Equipment costs from this 1972 study are representative of those in effect in late 1969.

Table VI-1: Equipment Cost Summary
(Montana)

Item	No.	Unit Cost	Total Cost
Drills, overburden	4	$ 149,000	$ 596,000
Drills, coal	2	14,400	28,000
Explosives truck	1	23,400	23,400
Dragline (including freight and erection)	1	5,782,000	5,782,000
Front-end wheel loaders, coal	2	129,000	258,000
Haulers, coal (bottom dump)	4	119,300	477,200
Supply truck	1	6,000	6,000
Sprinkler truck	1	32,000	32,000
Service truck (gas and oil)	1	30,000	30,000
Mechanics truck	1	6,000	6,000
Welding truck	1	8,000	8,000
Pickup trucks	6	3,500	21,000
Utility life truck	1	24,000	24,000
Electrician truck	1	5,000	5,000
Scrapers	2	157,000	315,000
Motor grader	1	69,600	69,600

Table VI-1 Cont'd.

Item	No.	Unit Cost	Total Cost
Dozers	3	$ 103,000	$ 309,000
Rippers, hydraulic for dozers	2	11,700	23,400
Pumps, sump	2	5,000	10,000
Towers, floodlight	10	1,800	18,000
Automobiles	2	3,800	7,600
Carryalls, personnel	2	4,500	9,000
Substation, power	-	-	50,000
Transmission line, power (initial installation)	-	-	15,000
Unit-train loading facility	-	-	1,000,000
Pump, casing and well	-	-	15,000
Building, office	-	-	57,600 */
Building, shop	-	-	355,700 */
Building, warehouse	-	-	17,300 */
Building, washhouse	-	-	12,500 */
Shop, tools and equipment	-	-	250,000
Office furniture and supplies	-	-	50,000
Site preparation	-	-	22,200
Roads (initial)	-	-	225,000
Exploration	-	-	66,000
Total	-	-	$10,195,900

*/ Prices include all materials and labor.

Mining - Operating Costs

The same study has estimated annual production costs for a five million ton per year strip mine in Montana.

Table VI-2: Estimated Annual Production Cost (Montana)

	Total Annual Cost	Cost Per Ton
Direct Cost:		
Production:		
Labor	$ 479,500	$0.10
Supervision	100,000	.02
Subtotal	$ 579,500	$ .12
Maintenance:		
Labor	$ 133,600	$ .02
Supervision	39,000	.01
Subtotal	$ 172,600	$ .03
Total Direct Labor	$ 752,100	$ .15
Operating supplies:		
Explosives	$ 850,600	$ .17
Fuel, lubrication and hydraulic oils; grease and filters	111,000	.02
Spare parts	458,900	.09
Tires	150,300	.03
Office supplies	1,000	
Miscellaneous	169,800	.03
Total Operating Expenses	$1,741,600	$ .34
Power	$ 126,000	$ .03
Payroll overhead (35% of payroll)	263,200	.05
Union welfare	1,000,000	.20
Rent, royalty and strip license	1,150,000	.23
Subtotal	$2,539,200	$ .51
Total Direct Cost	$5,032,900	$1.00
Indirect Costs: 15% of direct cost and supplies	$ 393,000	$ .08
Fixed Cost:		
Taxes and insurance (2% of plant cost)	$ 249,900	$ .05

Table VI-2 Cont'd.

	Total Annual Cost	Cost Per Ton
Depreciation	$ 920,600	$ .19
Deferred expense	347,000	.07
Total fixed cost	$1,517,500	$ .31
Total annual production cost	$6,943,400	$1.39

We have contacted firms presently engaged in strip mining in Montana and asked two questions. First,"are the costs as shown on the above tables (VI-1 and VI-2) representative of present equipment and operating costs?" The response was a resounding "no". In equipment costs, increases ranged from 25% to several times more on some items. Approximate increases in mining materials range in the 80 percent range, with over 40 percent taking place in the past year. Because costs have risen so much and are still on the rapid increase we have concentrated on documenting purchasing patterns of equipment and materials.

The second question was: "which of the equipment and operating cost items are available locally, and which are actually purchased locally?" As one might expect, we found that among the responding firms some items are purchased locally, but many must, of necessity, come from outside the area. Those necessarily coming from outside

include draglines, electric shovels, coal and overburden drills, coal haulers and explosives. Mining machinery also used in heavy construction -- front-end loaders, scrapers, graders, dozers, etc. -- were available in larger trading centers -- particularly Billings -- and were frequently purchased there as were spare parts.

Automobiles, pickups, carryalls and trucks were available and purchased locally in Montana, Wyoming or North Dakota, but not always in Montana.

Coal-Fired Generation - Construction and Operation

Presently there are two 330 megawatt units well under construction in Montana. Two additional units, 700 megawatts each, are proposed, all by Western Energy Company and several other firms. The two under construction provide the best and most current source of information for cost estimates and factor purchasing patterns for a coal-fired generation plant in Montana in the middle 1970's. The following table, from "Colstrip Generation and Transmission Project", summarizes the investment cost of the two units under construction, as well as those proposed.

Table VI-3: Colstrip Power Complex
Cost Estimates */

Item	Units 1 and 2	Units 3 and 4
Structure and Facilities	$ 30,187,000	$ 58,880,000
Land	150,000	150,000
Boilers and Turbine	51,120,000	99,561,000
Misc. Plant Equipment	20,953,000	40,681,000
Adjustment to Scope	4,605,000	8,921,000
Emission Control	16,500,000	26,539,000
Fees and Engineering	11,256,000	21,768,000
Field Costs	12,508,000	24,266,000
Water Supply System	7,000,000	12,839,000
Property Taxes	3,635,000	7,692,000
Contingency	8,665,000	16,773,000
Escalation	16,800,000	38,782,000
Total	$183,379,000	$356,852,000

*/ All items represent costs during construction.

In material provided by the Bechtel Company, major contractor of Colstrip 1 and 2, of $32,271,240 worth of subcontracts, 80 percent went to out-of-state contractors. And this does not include the major item -- boilers and turbine.

Once the plant reaches operation and the bugs are out of the system, it becomes largely a maintenance situation. Other than maintenance and minor replacement, the plant requires few capital inputs.

Although operating expenses vary widely with the type of plant, Table VI-4 spells out the range of individual items as a percent of total operating costs of a large plant.

Table VI-4: Itemized Operating Costs
Of A Large Thermal Generating Plant, As A Percentage
Of Total Operating Costs */

Item	Percent
Fuel	75-85
Labor	5-15
Maintenance Labor and Supplies	5-20
Supplies	1-5
Supervision	1-2
Operating Taxes	0-10

*/ Skvotzki and VoPat, Power Station Engineering and Economy, McGraw-Hill, New York, 1960.

Electric Transmission

If power is generated from coal, it must be delivered to the ultimate consumer. Electric transmission requires the construction and operation of transmission lines.

Table VI-5, provided by the U.S. Bureau of Reclamation, details total cost per mile for various transmission configurations. Reclamation estimates that these field costs comprise 50 percent for steel, 15 percent for foundations and 35 percent for conductor.

Table VI-5

TRANSMISSION LINES - FIELD COST PER MILE
January 1974 Prices

Conductor Size-ACSR (MCM)	WOOD H-FRAME (With 2 OHG Wires) 1 conductor per phase 230-kv	WOOD H-FRAME (With 2 OHG Wires) 2 conductor per phase 345-kv	SINGLE-CIRCUIT STEEL TOWER (With 2 OHG Wires) 1 conductor per phase 230-kv	SINGLE-CIRCUIT STEEL TOWER (With 2 OHG Wires) 2 conductor per phase 345-kv	SINGLE-CIRCUIT STEEL TOWER (With 2 OHG Wires) 3 conductor per phase 500-kv	DOUBLE-CIRCUIT STEEL TOWER (With 2 OHG Wires) 1 conductor per phase 230-kv	DOUBLE-CIRCUIT STEEL TOWER (With 2 OHG Wires) 2 conductor per phase 345-kv
795	40,600	81,900	53,700	89,100	-	93,900	151,200
954	43,800	90,700	58,100	98,500	136,600	103,500	170,600
1033.5	45,400	94,900	60,100	103,100	143,500	107,900	180,200
1113	46,900	99,400	62,300	108,000	151,100	112,700	189,700
1272	50,300	107,900	66,600	117,300	164,600	122,200	208,600
1431	53,600	116,500	71,000	126,700	-	131,800	229,300
1590	56,700	124,900	75,100	136,000	-	141,300	248,800
1780	60,500	135,500	80,400	147,200	-	152,800	272,200
	310*	388*	194*	233*	1/	256*	310*

Field costs shown include normal construction road costs and contingencies, but do not include any amounts for land and rights, relocations, clearing, access roads, service facilities, investigations, construction engineering, preparation of designs and specifications, construction supervision, or other general expense.

* Annual O&M Cost/Mile.
1/ Annual O&M Cost/Mile for 500-kv not available.

Discussions with Montana's largest electric utility indicate that most capital requirements for an electric transmission line must come from outside the state. Steel towers and the very high wooden poles needed for transmission systems are unavailable in Montana. (The smaller 30-45 ft. poles used for distribution are available and purchased within Montana.) The conductor, although available and generally purchased through in-state distributors is no longer produced in Montana. This has been the case since the closure of Anaconda's mill in Black Eagle several years ago. Insulators and other hardware are also from outside the state but available locally through distributors. Other items used in maintenance and construction, such as vehicles and replacement poles, are generally purchased in the local area if available.

Rail Shipment of Coal

Although it is difficult to allocate costs and benefits to the coal hauling by such a large transportation firm as Burlington Northern, some statements can be made. Rail transportation is capital intensive, with the capital having a long life but requiring regular maintenance. Expanded coal production for export will surely necessitate substantial new railroad investment and employment.

At the Project Independence Hearing in Denver in August 1974, Louis W. Menk, Chairman of the Board of Burlington Northern, Inc., stated that by 1982 Burlington Northern would have 786 diesel electric units in unit coal train service alone. The coal car fleet will increase from 3,400 at the present time to 18,000 by 1982.

Mr. Menk stated that Burlington Northern currently has a rolling stock of 3,400 coal cars and over 216 high horsepower locomotives serving the western coal.[22/]

Energy Intensive Industry

Historically, the availability of large quantities of usable energy at a reasonable cost has been an important factor in the location decisions of plants employing energy-intensive processes. Examples of Montana include the aluminum reduction plant of the Anaconda Aluminum Company at Columbia Falls near the Hungry Horse hydropower plant, and the Anaconda Company operation in Great Falls,

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22/ Summary Report, Project Independence Hearing, Denver, Colorado, August 22, 1974.

adjacent to several runs of the river dams on the Missouri. In this section, we will look at various types of energy-intensive activities which could locate in the coal field area, as well as processes which might utilize carbon by-products. Lastly, we will look at the likelihood of having excess capacity available and at the possible costs of power from new coal-fired plants.

Uranium Enrichment

According to a recent U.S. Government study,[23/] electricity generated with nuclear energy is expected to exceed that from all other sources in this country by the year 2000. If that is to take place, tremendous quantities of nuclear fuel will have to be made available. In June of 1973, two officials of the Bechtel Corporation briefed Montana officials on uraniun enrichment.[24/] At that time, they reported that three plants were currently being operated in the United States by the U.S. Atomic Energy Commission.

23/ U.S. Dept. of the Interior, "United States Energy Through the Year 2000," Washington, D.C., December 1972.

24/ Mr. Howard E. Shaw and Mr. E. Ward Botsford, Scientific Development, Bechtel Corporation, met with Montana officials in Helena on June 6, 1973.

They stated that in order to keep up with free world needs one plant per year would be needed. (The time frame and quantitative basis for this statement were not expressed.) The enrichment process takes concentrated uranium ore (containing U-235) and further concentrates this quantity to 2.5-4 percent U-235, which is then usable as nuclear power plant fuel. The output of U-235 from this gaseous diffusion plant would fuel approximately 75 nuclear power plants of 1000 megawatts each.

The following resource, investment and economic impact figures were provided:

Natural Resources:

Coal: Ten million tons of coal will be burned annually to generate the 2,500 megawatts of power needed for operation of the plant. A total coal reserve of one-half billion tons is required at the plant location.

Water Consumption: 22,000 AF annually, enrichment plant
35,000 - 40,000 AF annually, power plant

60,000 - 65,000 AF total

Capital Investment: 1-1/2 billion in enrichment plant
1-1/2 billion in power plant

3 - 4 billion total

Employment: Construction force 4,000 - 6,000 workers, enrichment plant; 2,000 workers, power plant.

Operation and Maintenance: 1,000 employees, enrichment plant, plus additional employees (figures not given for the power plant and mine

Effluents/ Emissions: "Small" amounts of flouride.

"Slight" amounts of alpna particles.

Within the past several months, it has been announced that a gaseous diffusion uranium enrichment plant would be built by a private consortium in Alabama. How this will affect the need for more nuclear fuel is currently uncertain.

Coal Gasification

A major process converting the coal from solid elemental carbon to a gaseous hydrocarbon is called "gasification". This process has been the subject of extensive discussion. The final product, a synthetic gas, is of sufficient cleanliness and heat content to be shipped by pipeline and used as a substitute for the natural gas now so extensively used in home heating and industry.

Much has been said elsewhere -- both in and out of this report -- on the subject of gasification impacts. The subject of interest here is the likelihood of gasification occurring. Although at least two firms have announced a serious interest in constructing and operating a gasification plant in Montana, thus far none have been serious enough to file an application to construct under Montana's Utility Siting Act.

The two firms and their plans are as follows. A joint venture of Northern Natural Gas and Cities Service Gas Company has expressed an interest in constructing four "standard" synthetic natural gas plants in Southeastern Montana. Each plant would produce 250 million standard cubic feet per day. The complex would consume 108,000 tons of coal per day; nearly 40 million tons per year. Peabody Coal has agreed to supply 800 million tons of coal (enough to supply the plant for 20 years) and the gas companies are negotiating for another like amount. Through 1975, $10 to $11 million will be spent on initial development; construction could start in 1976-77 with operation in 1979 or 1980.[25/]

Another announced plan is that of Colorado Interstate Gas and Westmoreland Resources Company to build one "standard" synthetic natural gas (SNG) plant in Southeastern Montana. This plant would use 25,000 tons of coal per day; or 9 million tons per year. Colorado Interstate has an option on 300 million tons of coal and 10,000 acre feet per year of water to be supplied by Westmoreland for development of the project.[26/]

25/ Interagency Synthetic Fuels Task Force, "Report to Project Independence Blueprint -- Federal Energy Administration, Supplement I," July 8, 1974.

26/ Ibid.

Table VI-6 outlines the selected impact data for the El Paso gasification plant in Farmington, New Mexico.

Table VI-6: Selected Impact Data for 288 Million Cubic Feet Per Day El Paso Gasification Plant, Farmington, New Mexico, First High BTU Gasification Plant To Be Built Using Western Coal, Proposed To Be On Line in Mid-1978

Plant Requirements:

Employment	883 employees
Water	8,250 acre feet per year
Land	1,915 acres

Mine Requirements:

Coal	9,383,000 tons per year (8,664 BTU per pound)
Employment	351 employees
Water	2,110 acre feet per year (mine operation, irrigation, dust control, etc.)

Plant Emissions:

Hydrogen sulfide (H_2S), carbon disulfide (CS_2), carbonyl sulfide (COS) -- combined emissions of these three compounds from any stack shall not exceed 100 parts per million (ppm) by volume. H_2S by itself will not exceed 10 ppm by volume.

Hydrogen cyanide (HCN) -- emissions from any stack not to exceed 10 ppm by volume.

Hydrochloric acid (HCl) -- emissions from any stack not to exceed 5 ppm by volume.

Ammonia -- emissions from any stack not to exceed 25 ppm by volume.

Project Employment	1,234 employees
Secondary Jobs	2,468 employees
Total New Employment	3,702 employees
Total Population Increase	9,625 people

(Note: The population data do not reflect the construction force.)

Exotic Plants

Energy and carbon-based products are involved in virtually all types of manufacturing. Thus, there is potentially a universe of activities which could be attracted by energy and carbon; many in concert with other resources. While at present the projection of these activities in Montana is best suited to the talents of an old-time fortune-teller, there are some indications of what we might see.

Fertilizer/Synthetic Diesel/Methyl Fuel: Dreyer Brothers, Inc., a wholly owned subsidiary of Burlington Northern, Inc., has announced its intention to construct and operate an industrial complex in the lignite fields of McCone County in Northeastern Montana. This complex would utilize coal and water to produce ammonia fertilizer and possibly liquid products such as methanol-methyl fuel and synthetic diesel fuel.

They have talked in terms of producing 1,000 to 3,000 tons per day of ammonia; 2,500 to 5,000 tons of methanol-methyl fuel, and 10,000 to 30,000 barrels per day of synthetic diesel fuel. Resource requirements would be 13,500 to 35,500 tons of lignite per day, and 12,000 to 32,000 acre feet of water per year. Annual coal requirements would range from nearly five million tons per year to nearly 13 million tons per year.

Glass: Another so-called exotic (to Montana) process which could utilize coal, is the production of glass. Glass, comprised of silica (sand) which has been heated to the melting point, could probably be manufactured in Montana using coal for the heat source. To date, no such plans have been announced.

Excess Capacity and Power Prices

Although not based on detailed analysis, present circumstances and the outlook for the future suggest that there will probably not be significant excess capacity in generation in Montana for many years to come, if at all. Power for Colstrip 1 and 2 is spoken for; as is that for 3 and 4 if they are constructed. Currently, no others have been announced or applied for. Furthermore, although the plants are the latest design and least cost as of today, their power is still expected to be expensive when compared, for example, with hydropower produced by existing capital in the Columbia. Beyond that, the apparent position of Montanans is that energy, if it should be developed at all, should be developed where there is clearly a valid need. Surely such a need would have to be shown before the power development would be approved.

Displaced Activities

Four basic natural resources -- coal, land, water, air -- are necessary for existing and proposed coal mining and conversion operations. As documented in Chapter II of this study, coal reserves realistically pose no limit to potential coal-based development. Further, in the predictable future, non-energy uses of Montana coal are not likely to be precluded by conventional coal consumption.

Land and water, of course, are in limited supply. Future industrial use (pollution) of the Eastern Montana airshed also could displace existing commercial activities. Agriculture and tourism are most likely to be impacted by energy development.

Surface Water: According to the U.S. Bureau of Mines,[27] current industrial water use in Eastern Montana is minimal and probably amounts to less than 10,000 acre feet per year (afy). In contrast, irrigation accounts for approximately 98 percent of all water consumed statewide.

As discussed in Chapter VII of this study, the NGPRP Draft Summary Report projects (high coal development profile) that the Northern Great Plains energy industry will consume 800,400 acre

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27/ Persse, F. H., and Willard, D. G., "Projected Water Requirements of New Mineral Industry in the Powder River Basin, Montana and Wyoming," U.S. Bureau of Mines, Preliminary Report 1972.

feet of water in the year 2000. Total corporate interest in Yellowstone Basin water (federal water use options, 623,000 afy; applications for federal options, 1,180,000 afy; filed water rights yet to be adjudicated by the State of Montana, 587,440 afy; applications for state water rights, 973,000 afy) is much higher, however.

Recognizing that much of this potential demand for Yellowstone Basin water is speculative and somewhat duplicative, it is still clear that considerable displacement of non-energy water uses may occur. Early in this study, it was recognized that a massive amount of new data had to be gathered before a complex array of water use tradeoffs could be evaluated with authority. Accordingly, MEAC prepared "A Proposed Series of Projects to Evaluate the Potential Physical, Biological and Water Use Impacts of Water Withdrawals and Water Development on the Middle and Lower Portions of the Yellowstone River Drainage, Montana."

The Old West Regional Commission has executed a two-year, $500,000 contract with Montana state agencies to implement the study. The project should be recognized as a major spinoff from the U.S. Bureau of Mines' project and will provide definitive projections of the extents to which irrigation, city water supplies and "in-stream values" will be affected by industrial water consumption.

The final phase of the study involves an economic quantification of the projected displacements. It can already be predicted, however, that the coal industry will be able to pay a much higher price for Yellowstone Basin surface water than will all other competing users. Although the recreation and tourism industry does not pay for its use of Yellowstone Basin water, an economic displacement will occur if in-stream values diminish significantly.

While economics will play a role in resolving future water use conflicts, the decisions must involve political, social and life style considerations difficult to quantify.

We will return to a basic question: "To what extent should Eastern Montana shift from rural social and economic systems to an energy-industrial society?" Shifts from agricultural to industrial uses of water have already occurred as energy corporations purchase existing water rights historically used for irrigation.

Groundwater: Disruption of groundwater flows and degradation of groundwater quality will decrease the productivity of impacted farms and ranches. In the Fort Union coal area, the coal seams themselves are generally the best aquifers in terms of both quantity and quality of water. If the target coal deposit serves as an aquifer, large strip mine operations unavoidably disrupt groundwater

flow. As detailed in a recent hydrologic study,[28/] water levels in monitoring wells near the Decker strip mine have dropped up to 25 feet during the first year of major mining operations.

Equally important, Van Voast summarized present knowledge about impacts of strip mining on groundwater quality as follows:

> "Spoil leachates sampled near Colstrip (Van Voast, 1973, and Montana Bureau of Mines and Geology unpublished data) contained dissolved solids concentrations much greater than waters sampled from nearby shallow aquifers; calcium and magnesium were found in much greater concentrations than sodium. The spoil waters also contain small concentrations of trace metals including copper, lead, zinc and nickel not found in other local waters. Near Decker, spoil waters are not yet available for analysis; the relatively high concentrations of sodium in waters in local aquifers corresponds with the high sodium concentrations found by Hodder and Sindelar for simulated spoils. If simple projections are valid, it can be predicted that spoil leachates at Decker will be even more strongly mineralized than those near Colstrip and that the principal cations will be calcium, magnesium and sodium."

Shaley overburden materials, high in soluble salts and highly impermeable before mining, provide significant dissolved solids to percolating groundwater once they are fragmented and deposited in spoil piles. Diminished quality can make water as unavailable for livestock use as can the drying up of a producing well.

28/ Van Voast, Wayne, "Hydrologic Effects of Strip Coal Mining in Southeastern Montana -- Emphasis: One Year of Mining Near Decker, Montana," Montana Bureau of Mines and Geology Bulletin.

On a regional basis, the impacts of strip mining on groundwater are not likely to be of major consequence. But to the individual rancher who loses a water supply for his cattle, the consequences are overpowering. Premining site-specific studies are necessary to predict impacts of mining on groundwater and to determine if alternative water supplies are available.

Land: Analysis of economic displacements resulting from occupation of land by the coal-energy industry must be subjective. The big unknowns, of course, are the nature and magnitude of future coal development.

In an attempt to quantify potential land use trade-offs, the NGPRP made detailed projections for six counties in the Northern Great Plains Region. Combined year 2000 net disturbances (disturbed acres less reclaimed acres) in Big Horn and Rosebud Counties are 10,581 acres, 24,642 acres and 57,685 acres for the low, most probable and high development scenarios, respectively.

Combined gross disturbances were 21,493, 40,498 and 78,832 acres for the three scenarios.

In both counties, 80 percent of the projected disturbances would impact rangeland. Forest lands would host ten percent of the disturbances in Big Horn County and 15 percent in Rosebud County, with the remaining disturbances falling on cropland (wheat and alfalfa).

A meaningful economic comparison of agriculture and mining must consider net returns to each venture on a comparable time basis (present value), as well as external costs and benefits of each. Such a comparison is a difficult one to make. Although a comparison of gross returns does not satisfy the above requirements for a meaningful economic comparison, it does give some feeling for the order of magnitude of each.

According to Struck,[29/] over one thousand years of wheat production would be required to equal the value of a representative acre of coal at 1973 prices. Struck gave few specific figures and MEAC proceeded after making a number of assumptions.

With a wheat yield of 30 bushels per acre and a price of $4 per bushel, gross returns on one acre would equal $120. That same acre, if it would yield 40,000 tons of coal at $3.00 per ton would provide gross returns of $120,000, a thousand times more. However, without a calculation of net returns to each, the selection and application of an acceptable discount rate, and the inclusion of external costs and benefits, we can draw no firm conclusions. Beyond narrow economics, the basic socio-political question is still unanswered. To what extent should Eastern Montana shift from a rural to an industrial society?

29/ Struck, David G., "Land Use -- Coal Strip Mining and Agriculture," Draft WICHE Report to Montana Department of Natural Resources and Conservation, September 1974.

From these observations, two conclusions become obvious. State decisions regarding implementation of non-degradation provisions of the recently issued EPA air quality regulations are critical to long-term air quality in Eastern Montana and areas downwind. Secondly, it seems apparent that the option of allowing coal industrialization to raise pollutant loads to levels set by ambient air standards could cause economic dislocations in existing Montana enterprises.

Montana tourism, which "sells" a clean, uncrowded environment, would surely be impacted if visibility and generally air quality paralleled conditions in major urban, industrial areas. Also, the long-term cumulative impacts of SO_2 and trace element emissions on sensitive crops and native vegetation is simply not known. Although a number of relevant studies are proposed or underway, no accurate predictions can be made about sustained agricultural productivity downwind from western coal conversion facilities.

Goods and Services for Energy-Related Employment

This section looks at the effects on the economy associated with the expenditures made by primary coal-based employees, and their needs for services from the public sector.

Primary/Derivative Relationships

One important way that money flows from its source through the economy is through the expenditures of primary employees. "Primary" and "derivative" are terms used by regional economists to differentiate between those jobs and incomes based directly upon those industries which sell their products outside the area or are otherwise influenced by factors outside the study area and those which serve the local area. Basic primary industries, also known as export industries, often include agriculture, certain types of manufacturing railroads and mining -- including coal. Derivative (also often called service) industries include retail trade, services and local government. The general understanding is that primary incomes occur, and then are spent on derivative activities. Thus, workers (perhaps mine workers) receive their pay and, in turn, spend a portion of it buying goods and services from local merchants. As the money is spent and respent in the local economy, additional derivative income

and earnings are created.

Polzin has investigated the primary/derivative relationship in some detail. He has looked at earnings of coal-related employment and estimated that associated increase in derivative earnings in the three-county local impact area and the larger seven-county area (which includes the trade centers of Miles City and Billings). Table VI-7 from his report summarizes his findings. Table VI-7 is on the following page.

Thus, Polzin estimates that $1 in coal worker earnings will generate $.50 in local area earnings, and an additional $.90 in the remainder of the seven-county area for a seven-county total of $1.40 in derivative earnings.

These estimates are for permanent operational workers. During the construction period, it is likely that different relationships between primary and derivative will be in effect. Because of worker mobility, and the general short-term nature of construction, construction earnings are expected to have a smaller impact on derivative earnings than equivalent permanent earnings.

Polzin has estmiated that changes in derivative earnings resulting from construction will be one-half those resulting from longer-term, coal-related earnings. Thus, he estimates that $1 in construction earnings will increase derivative earnings in the seven-county area by $.70, and $.25 in the three-county area.

Table VI-7

Relationship between Primary and Derivative Sectors in the Economic Impact Areas

	Three-County Impact Area[a]	Seven-County Impact Area[b]
Change in derivative earnings for each dollar ($1.00) change in:		
Earnings of coal-related workers	$0.50	$1.40
Gross farm receipts	0.15	0.50

[a]Big Horn, Powder River, and Rosebud counties.

[b]Big Horn, Powder River, Rosebud, Custer, Musselshell, Treasure and Yellowstone counties.

Public Service Needs

This subject area is covered in some detail in the sub-heading "Demands for Services" in Human Values, Chapter VII of this report.

Polzin went to great length to understand and describe the expected increases in both tax revenues and government expenditures. But, in concluding, he very carefully clarified the fact that even then he could not say which would be greater. And, to yet expand the feeling for the problem, he added discussion on the lags of tax revenues (particularly Montana property taxes on "new industry") and the short-run peaks of demands for public services caused by contruction periods. Furthermore, depending on the place of residence of workers, and other factors, taxes may not be collected by those levels of government with the responsibility to provide the needed services.

CHAPTER VII.

HUMAN AND NATURAL VALUES

Human Values

A Brief Introduction to Montana History

The history of Montana is that of a state created out of and, until recently, maintained for the exploitation of natural resources. Early day visitors came here for furs or freedom. A short time later, gold, silver and, eventually, copper attracted a rapid influx of population, whose primary purpose was to make it big and go back home. With the increase in population came an increase in the awareness of the mineral riches of Montana which, in turn, attracted the intense attention of large capital interests. Simultaneously, as the cattle industry grew in the Southwest and spread North, the vastness and productivity of the Montana plains attracted still more interest. Cattlemen, followed by sheepmen, moved in. Growth in Montana population, and especially in the mineral extraction and refining industry, created a great demand for timber products to be used in construction and as fuel. The timber industry was born.

Later, as the rest of the nation came to notice the expanse of the Northern Great Plains, and the needs of immigrant and urban populations, the Homestead Act was passed. Initially, only a few came to Montana. But the word spread, aided by the interest of the railroads who wished to carry freight in both directions. Land speculation became a profitable venture. In little time, Montana's prairies were

dotted with families and single men trying to pull a living from that productive Montana prairie. Unfortunately, many of those homesteaders had no agricultural experience -- none had experience with agriculture in semiarid plains. Not only were the land allotments too small, the farming techniques were all wrong. And the prairie, already damaged by overgrazing, began to blow.

There was, and still is, big money to be made in Montana. But, as with other opportunities, big money makes the biggest money. Early in the development of Montana's riches, large financial interests in the East and in foreign nations began to acquire control of the major mining operations. Similar patterns also occurred with respect to the livestock industry, though to a less significant degree. As the controlling interests in the "development" of Montana became increasingly controlled by entities located elsewhere, so also did the control of many other aspects of life in Montana. In short, much of significance that occurred in Montana was arranged by and conducted for the benefit of groups or persons who did not reside here. Montana residents were only those who dug in the hills, cut the trees, ran cattle or tilled the soil.

Government was organized in Montana, but history shows that, until recently, it operated at the whim of large corporations. Labor organized in Montana, but until fairly recently, it had little effect on working conditions or wages. Radical farm groups formed but they had little long-term impact (though their bloc aided in the election of a "renegade" governor, Dixon, and two "renegade" senators, Walsh

and Wheeler). A Montana press evolved. However, with the exception of two major dailies and a few weeklies, it was owned until the late fifties by the state's largest mineral firm.

Given a system of this order, it is little wonder that the land and minerals of the state have been exploited, with little lasting benefit to residents. It is little wonder that popular "uprisings" have been met by, to quote Toole, "genuine suppression of civil rights, riots and lynchings". This system, combined with the harsh realities of weather and life in the Northern Rocky Mountains and the Northern Great Plains, also resulted in the ruination of thousands of homesteaders and thousands of acres of prairie land. This system also created vicious cycles in the local fortunes of the timber and minerals industries.

Montana's distance from major market and population centers guaranteed that little of her abundant wealth would stay at home. The Montana economy is tied to the market fortunes of her raw materials -- minerals, agricultural products and timber products. When the nation wants these products, Montana prospers. When the nation wants other products, Montana suffers. There may be little Montana can do to correct this relationship, again due to our distance from others and our sparse population.

Those who stuck it out, and became Montanans, did so through stubbornness, hard work and adaptability. Like the American Indians who preceeded them, and who themselves were horribly exploited and abused, Montanans learned that in order to survive and thrive in

Montana, one had to understand the natural system and to adapt to it. The Northern Rockies - Northern Great Plains system does not lend itself to control by the works of man. Man learns to adapt to the system. Those who do not, like many homesteaders, stockmen and timbermen, eventually find themselves without a means to make a living. Those who could not or would not accept the consequences of their actions found themselves in similar straits. And those who could not or would not help others in need found themselves alone when their inevitable reversal in fortunes occurred.

As those who became Montanans became proficient at survival, they learned a healthy skepticism of pat answers and traditional ways of doing things. As they came to understand their complete dependence upon a healthy, natural system and the willingness of others to acknowledge and respect this dependence, they have come to resent those who would ignore these realities. This understanding, skepticism and resentment has been a long time in coming and it is far from universal. But, it does exist. And, with these traits has come an unwillingness to repeat the mistakes of the past, both in our relationship to our environment and in our relationship to our governments.

Those who live here do so out of desire, not necessity. There are always jobs to find and more money to be made elsewhere. The consistent outmigration of some of Montana's young adults is proof of this. Tragic as this migration may be, those who stay are coming to feel that such outmigration is but another fact of life in Montana. Those who stay are willing to forego many of the benefits of the

"progress" apparent in much of the rest of the nation. Many regard that progress as illusory in any case.

Remembering their history, Montanans are both suspicious and fearful of the nation's current interest in yet another of their natural resources. Montanans are again beginning to hear the statement, this time from energy company and federal officials, that they should start shouldering their share of the burden and stop freeloading from the rest of the nation. Montanans know better. In every single national emergency since Montana became a state, Montanans have given more than their share of human and natural resources and have received for their efforts little more than pride in a responsibility well met.

Montanans have heard the terms "minimal impact" and "reasonable sacrifice" before. And, they remember wasted prairies, clear-cut forests, mine dumps, waste and silt clogged streams and polluted air. Montanans have read, also, of Appalachia. Finally, Montanans think of the lasting treasure Montana represents. Clear blue sky, clear fishable waters, snow-capped mountains, great expanses of plains almost mysterious in their variety, populations of wildlife long since driven from so many "progressive" states, and a social system that allows the individual to stretch and grow -- all these are assets that Montanans <u>will</u> preserve, for themselves and for the rest of the nation.

Projected Changes in the Demographic Composition of Selected County Populations

The primary locus of anticipated coal development in Montana is within a six-county area in Southeastern Montana. The counties most likely to be immediately affected by coal development are Big Horn, Custer, Powder River, Rosebud, Treasure and, to a lesser degree, Yellowstone Counties. Other coal development activities may occur in other Eastern Montana counties, especially in Garfield, Prairie, McCone and Dawson Counties, if coal gasification technologies come to fruition. However, no research has been done, to date, in anticipation of development effects on demographic characteristics of the populations of those counties.

It should be noted that the anticipated development effects to be presented below are localized in nature. Except for possible shifts in political balances and ideologies, the changes are apt to be noted only within those counties in which development occurs, and within adjacent counties to a lesser degree.

Generally speaking, five of the six counties to be most immediately affected by coal development are primarily rural, agricultural counties. Yellowstone County, as a major trade center, a site of significant petroleum activity and the state's largest urban population, is the exception to this trend. Yellowstone County also is the county in which coal development is expected to have the least immediate impact.

While the remaining counties are primarily agricultural and rural, the proportion of the population engaged in agricultural activities has declined. Government and oil extraction employment has increased. This is especially true in Powder River County where oil and gas production activity has been high, although it has declined somewhat in recent years. Custer County, the site of numerous federal offices, a V.A. hospital, a state industrial school and a community college, has relatively high government employment. The county seat of Custer County, Miles City, also is the largest community and trade center among the five rural counties.

More specific discussions of the counties are presented below.

Big Horn County

Big Horn County, with the twentieth largest county population in Montana, has the state's second highest proportion of non-white persons as residents. The non-white representation is due almost entirely to the Crow Indian Reservation. The county also displays the highest fertility rate and second highest crude birth rate in Montana, again due, primarily, to the Crow Reservation.

Per capita income and level of educational attainment in the county are the third lowest and lowest, respectively, of all Montana counties. The civilian labor force is largely employed in blue collar, farm or service occupations (62.3 percent of CLF).

Assuming large-scale coal development, Jobes (research done on contract to the Department of Natural Resources and Conservation, 1974) projects pronounced demographic change over the next 30 years. The young age structure noted in the county is expected to remain relatively unchanged although the ratio between white and non-white populations is expected to stabilize. This is due to the assumption that the majority of immigrants attracted by coal development will be white. The trend of slow, steady population increase in Big Horn County is expected to be replaced by rapid and steady increase. Jobes expects some increase in level of educational attainment of the county populations and a proportional shift to industrial employment, with a decline in agricultural employment.

Custer County

Custer County is the fourteenth most populated county in Montana, with 74 percent of its population residing within municipalities. The age structure of the county is relatively old, with outmigration noted among the productive years population group. Like many Eastern Montana counties, Custer has lost population gradually during past years. The minority component of the county population is small.

The median family income of the Custer County population is nearly average for Montana, ranking twentieth in the state. A high percentage (70.6 percent) of the labor force is employed in white collar or government occupations. The level of educational attainment is near the Montana average.

Assuming large-scale development, Custer County is expected to see a reversal in the trend of net population loss. Miles City, as the county seat and an area trade center, is expected to expand in response to development demands in the goods and services sectors. Jobes expects little change in county population characteristics. If change is noted, Jobes expects it to occur in the age structure of the county, with an influx of younger persons. Some increase in the blue collar occupational group may be noted.

Powder River County

Powder River County has the second smallest population in the state, and is entirely rural. The population displays a high fertility level and a relatively young age structure. The level of educational attainment of the population is near the state average.

Major occupational groups are related to agriculture and extraction of petroleum resources. Powder River County ranks lowest in the state in proportion of government workers and nearly the lowest for white collar employees.

Due to major development of petroleum resources, the county population displays high employment levels, high median family incomes and low poverty levels. In contrast to most rural Montana counties, the Powder River County population grew 15.2 percent in the decade 1960-1970.

Assuming major development, Jobes predicts considerable change in Powder River County. As coal development proceeds, transportation facilities will necessarily expand, in effect opening up Powder River

County to persons attracted to the area by employment opportunities. Given this occurrence, population increases, largely by non-rural, non-farm groups, will create additional demand for government and community services that now barely suffice the needs of present residents. In addition, the advent of sizeable numbers of newcomers is apt to result in the development of urbanized areas.

Rosebud County

Like many other rural Montana counties, Rosebud County lost population in the decade between 1960 and 1970. Since 1970, however, Rosebud County has experienced significant and rapid growth in population.

Rosebud County has a large non-white population component, due to the presence of the Northern Cheyenne Indian Reservation, whose residents account for 30 percent of the county population. Like Big Horn County, Rosebud County displays a very high fertility ratio and crude birth rate (second highest and highest in the state, respectively), largely due to the presence of the reservation. The economic aspect of the county in 1970 was not particularly favorable; mean family income was fourth lowest in the state and per capita income was fifth lowest. Unemployment rates were high in 1970, and the population's level of educational attainment was among the lowest ten counties in Montana. Occupational opportunities were primarily in agricultural and service pursuits.

Rosebud County is now the site of the most intensive coal development activity in the state. Population growth has been so large and

rapid that community and government services have been unequal to demands (see III). Jobes predicts that this condition will continue and that Rosebud County will remain the Montana county most affected by coal development. Jobes expects that the age structure of the population will remain young until development activities are well established. Blue collar employment is expected to become the largest component of the labor force, displacing agriculture. Service and professional-managerial employment opportunities are apt to increase, as well. Jobes suggests that educational and economic levels will increase within the county but that these benefits will not be shared equally by the presently disadvantaged population groups.

Treasure County

With the third smallest population of all Montana counties, Treasure County lost population more rapidly than all but six counties (20.5 percent between 1960 and 1970). The age structure of the county is similar to that of other Eastern Montana counties, though more pronounced; slightly over 38 percent of the population was less than 18 years of age in 1970, while nearly 11 percent was aged 65 or older. The population group comprising adults in the productive years showed the greatest decline, due to outmigration.

Though the level of educational attainment in the county is high (sixth highest in Montana), and employment was high, median income levels were among the lowest in the state. Employment opportunities are primarily in the agricultural and service sectors.

Given large-scale development, Jobes predicts a slight increase in population followed by a gradual decline. Current educational and social characteristics of the population are not expected to change. Jobes does expect the occupational structure of the county to change to a higher proportion of non-agricultural and non-professional employment opportunities.

Yellowstone County

As the most populated county of the state, Yellowstone County incorporates one of the two, and the largest Montana Standard Metropolitan Statistical Area. Only a small percentage of Yellowstone County residents are rural farm or rural non-farm dwellers (4.7 percent and 8.6 percent, respectively). A high proportion of the county population is employed in manufacturing, government and white collar occupations. County median income is fifth highest in the state, and per capita income of residents ranks thirteenth.

County educational levels are well above the state average. The age structure of the county is one of a predominantly young population, with the disproportionately high young adult population contributing to a high crude birth rate (eleventh highest in the state). The age component of the county population is relatively low, with only 8.1 percent of county residents aged 65 years or more.

The county is expected to continue its growth, with or without coal developemnt, with its county seat, Billings, becoming increasingly important as a regional production and distribution center. Coal

development will only reinforce this trend.

Jobes does not expect development activities to significantly alter the age-sex, occupation, race or education structures of the county. In short, any foreseeable change resulting from coal development is expected to be only one part of the general development underway in the county.

Indian Reservations - Crow

Located on some 1.5 million acres of land, the Crow Indians numbered 4,334 persons in 1973, an increase of nearly 18 percent over the previous decade. The age structure of this population indicates an extremely young population, 43.6 percent of which is aged 16 or less. Just over 33 percent of the Crow population is aged 25 to 64; adults in the young productive years (25-44) number only 22.7 percent. Nearly two-thirds of the population is aged 24 or less. Unemployment on the reservation is very high -- 11.6 percent in 1970. The vast majority of employed Crows occupy agricultural or government jobs. Service sector employment also is significant.

Education and income levels of Crows also are low, with median family income equal to only 56 percent of the comparable national figure. Some 39.4 percent of Crow families had incomes below the poverty level in 1970.

Northern Cheyenne

Numbering 2,926 persons, the Northern Cheyenne occupy 434,420 acres of land just east of the Crow reservation. The Northern

Cheyenne population has grown 35.1 percent in the decade since 1963 -- a dramatic increase. The Northern Cheyenne are a young people too, with 64.8 percent of their population aged 24 or less. Less than one-third of the Cheyenne are aged 25-64; adults in the young productive years (25-44) number only 21 percent of the population. Cheyenne unemployment also is high at 11.1 percent in 1970. Primary employment on the reservation is in government and timber-related occupations. Service and agricultural employment account for about 25 percent of all jobs.

Median family income is quite low, just above that of Crows, as are education levels. Some 38.6 percent of Northern Cheyenne families had 1970 incomes below the poverty level.

Coal development could bring considerable benefits to both reservations, increasing employment opportunities and incomes. However, large-scale development could inundate both reservations with non-Indian populations foreign to and both unfamiliar with and unsympathetic toward Indian culture and values. There also is a question whether employment, based upon the extraction of coal reserves, will be acceptable to many Indian people. For these, and other reasons, considerable sentiment is growing on both reservations in suspicion of or opposition to coal development. Both Indian peoples have declared a moratorium on coal development within reservation bounds. The Northern Cheyenne have expressed some concern about coal development now occurring in Rosebud County and the influx of non-Indians it may engender.

With reference to the total primary impact area in Montana, the Northern Great Plains Resource Program has generated population projections for each of the three coal development profiles. For Montana, these figures are:

Table VII-1
Development Area Population (In Thousands)
Coal Development Profile

Year	I	II	III
1970	123	123	123
1980	142	144	180
1985	135	179	203
2000	157	187	267

The percent increase in development area population would be:

Table VII-2
Percent Change in Area Population Coal
Development Profile

Year	I	II	III
1970-1980	+15	+17	+46
1980-1985	- 5	+24	+13
1985-2000	+16	+ 4	+32
1970-2000	+28	+52	+117

Population changes of this magnitude certainly will have major impact, both in service demand and in demographic composition. Jobes, whose material was used above, did not work from the Northern Great Plains Resource Program development profiles. The Interim Report of the Northern Great Plains Resource Program indicates only

that demographic changes are bound to occur, but that, at this time, there are insufficient research data to justify specific predictions of the form of those changes. One should suspect a drastic shift in the relative proportions of occupational groups, with blue collar workers becoming dominant and agricultural employment becoming less significant. One also should suspect a significant increase in service sector employment. One would expect a reversal in the trend in many development counties wherein the very young and the very old constitute a disproportionate share of county populations. Finally, given the scale of development intimated by CDP's II and III, one could suspect that Indian populations will become a far less significant component of the area populations.

Impacts of Coal Development Upon Government Services in Southeastern Montana

The material presented below is taken from papers prepared under the aegis of the NGPRP and from personal communications with researchers, area residents and involved government officials. All the impacts described are essentially localized, with the major impacts seldom extending beyond the boundaries of the county in which development is occurring. As the NGPRP has noted in its Interim Report, the research done to date concerning areal impacts is far from adequate and does not permit firm conclusions to be drawn. However, it is hoped that what is presented below will provide the public and their

decision-makers some indication of what may be in store for residents and governments of development areas, should development proceed rapidly and on a large scale. It should be noted that the absolute scale of development now occurring in Montana is far smaller than that envisioned in the NGPRP coal development profiles. To date, major new development has been limited to the opening of a new strip mine, expansion of an old one and the construction of two 330 megawatt coal-fired, thermal electric generating plants (the latter sequentially).

Social and Economic Costs of Coal Development for Environmental Quality Council Report

The benefits of industrialization of Eastern Montana's coal reserves have been much touted. Increased revenues to state, county and local governments, more jobs at high wages and stimulation of "sagging" economies have been presented as immediate and lasting benefits. Attention to the known and possible costs of such development has been limited to the efforts of a few prestigious research organizations, state government, a few reluctant federal agencies and some small, but very capable, citizen's organizations.

Preliminary findings of research addressing such costs have begun to trickle in. Further, some attention has been paid to more detailed examination of the ostensible benefits of rural area industrialization. Some of the costs noted are quantifiable in a monetary sense. Many others are not presently quantifiable in that sense and, as a result, may be ignored. It is to those latter costs that the bulk of the following is addressed.

Effects Upon Groups, Structures and Organizations

Uncertainty: To date, little beyond conjecture is available to define the date, scope and type of industrial development to be expected in Montana's coal area. Until some decision is made by state government to define the development that is acceptable to it, and until some clarification of the degree to which the federal government will allow state self-determination is made, those groups who must deal with development will have to shoot in the dark. Assuming large-scale development is to occur, state, county and local governments must not only determine what demands such growth will place upon their services but must also devise plans to meet those demands and create mechanisms to support resultant programs and services. To overestimate demand is to commit the structure to investment in programs and structures that will be underutilized at taxpayers' expense. To underestimate demand is to insure that legitimate needs will not be met, that those responsible for demands are not apt to pay their share, and that the taxpayer, again, will be forced to meet an expense not of his making.

This problem is now affecting all levels of government in the coal development area in Montana, especially in Rosebud County. Staggering demands are being made now on local and county government services and resources. However, government bodies are experiencing difficulty in meeting those demands due to lack of financial resources and due to lack of a clear understanding of the ultimate level those demands will reach. It is not sufficient to respond simply to

immediate demand -- these government structures must comprehend the ultimate demand in order to generate appropriate, efficient and effective programs to meet both present and ultimate demands.

Similar effects are being noted in the commercial and voluntary sectors of service providers. According to Turner and McCaw (Office of Economic Opportunity, 1974) only financial institutions, and not all of them, are making plans to cope with the changes energy industrialization is expected to bring. Many local businessmen reportedly are holding up plans to expand the range of their services until such time as the limit of their potential market is known. As a consequence, goods and services in the Colstrip-Forsyth area are scarce and are priced high. Fears also exist that, with larger development, chain outlets will be drawn to the area, representing competition the locals can't meet and an outflow of profits to home offices. In addition, the housing and land markets are similarly affected. Housing and land are scarce, rents are very high, while local interests are reluctant to go too far overboard in the event of a sudden cessation or reversal of growth.

The primary industry of the area is similarly affected. Agricultural interests, many of which must expand regularly to stay competitive (see Gold, "A Comparative Case Study . . ."), are marking time in an attempt to determine whether capital outlays to increase productivity (more land, more equipment) will be profitable -- it is very possible that massive industrialization and agriculture will

prove incompatible. Ranchers are reluctant to buy land for fear they won't be able to use it; farmers are reluctant to buy additional equipment for the same reasons. Other ranchers are reluctant to sell land to the coal interests or land speculators, yet can't find a rancher to sell to.

The voluntary sector, alluded to above, apparently feels that it will be able to meet additional demands. Yet, Turner and McCaw doubt that these interests fully comprehend the potential magnitude of change in the demand for the services of these groups. As in any large rural area, these voluntary services (religious groups, civic groups, recreational organizations, specific purpose organizations) are extremely important and serve the needs of a great number of people.

These problems are doubly complex in the context of Colstrip, a company town. Not only must citizens, government and groups concern themselves with area development uncertainty, but also with the uncertainty over what responsibilities the company will assume to meet the needs their town has generated.

Antagonism: According to Gold, formal and informal relationships established among and between groups, that allow them to work together to achieve local goals, have begun to experience strains. The systems that operate in the area depend to a great degree upon trust and cooperation to get jobs done. This is particularly true with respect to the interaction between agricultural interests, and the commercial and finance sectors. Due to the magnitude of change

that has been experienced to date, and to differing positions with respect to the advisability of continued industrialization, these systems of interaction have begun to break down. Again, according to Gold, industrial interests have taken advantage of these strains and have worked to aggravate them further; in effect, to divide and conquer. As a consequence, suspicion and distrust between groups is reported to be increasing. Yet, in order to cope adequately with development demands, and to arrive at a position defining acceptable growth, channels of communication have to remain open.

These antagonisms also are reported to extend to the realm of social interaction among children in the Colstrip area. Divisions are reportedly beginning to form between children of the agricultural sector and the newcomers. Families are reported by Gold to be advising their children not to relate to children from the "other camp".

Demands for Services: Detailed data on government expenditures to meet increased demand for services have yet to be thoroughly tallied. However, discussion with local and county officials reveals a bleak picture, particularly in Rosebud County. The potable water supply system of Forsyth is being taxed to its limits, as is the sewage disposal system. The potable water supply in Colstrip was recently reported contaminated. Any increase in the capacity of the Forsyth system is apt to come at taxpayers' expense, although some federal assistance may be available. County officials also have reported that planning related to land use in the area is halting, at best --

this, in part, is due to limited financial reserves for support of a planning staff. Practically all land in the Forsyth area that is available for siting of mobile homes is being used for that purpose. The part-time county sanitarian (he is shared with two other counties) has predicted that serious public health problems may arise in the very near future.

Rosebud County has but one public health nurse. Interviews with this nurse have revealed that she is unable to perform all the services she would like to provide -- she is barely able to keep up with her responsibilities with school children. The Department of Health and Environmental Sciences has been providing some additional services such as family planning services on an intermittent basis. In addition, a $175,000 grant to build local health services in rural Eastern Montana has been awarded to the Department of Health and Environmental Sciences by the Old West Regional Commission.

While the Rosebud County service area has numerically adequate hospital and long-term care facilities, these are located in Forsyth, 35 miles from the Colstrip construction and mining site. The only health care facilities available in Colstrip are two mobile homes, one located on the construction site and the other closer to the housing area in Colstrip. These mobile units were provided by the Montana Power Company, are staffed by nurses, and serve as first aid stations and elementary diagnostic and referral centers. The Rosebud public health nurse and the Department of Health and Environmental Sciences personnel also use these units when programs are brought to Colstrip.

Rosebud County, like so many other rural Montana counties, has a shortage of health manpower. Those that do reside in the area were overworked before industrialization began.

The school system in Rosebud County, especially at Colstrip, has been severely affected by industrialization. While some of the space problems have been solved through a long-promised Montana Power Company donation of mobile homes, to be used as classrooms, classes are still very large. Several courses formerly offered have been dropped as luxury items, as the teaching staff struggles to meet increased demands. Many individuals have complained that the quality of education offered by the Colstrip school has declined. Newcomers to the area also complain about the lack of certain courses.

Recreational opportunities in the Colstrip area are very limited. Formerly, the school building and the Colstrip interdenominational church were used as recreation sites for young and old alike. Now, both are too overcrowded for use on a regular basis. There are no other indoor recreational facilities in Colstrip. Consequently, at quitting time and on weekends, there is a mass exodus from the area, with many, newcomers and locals alike, going as far as Billings to "get away" (see Gold, 1974, and also personal correspondence with him).

The incidence of crime in Rosebud County has skyrocketed. In 1972, total felony and misdemeanor arrests totaled 129 arrests (7 felonies, 122 misdemeanors); in 1973, this figure rose to 835 arrests (13 felonies, 822 misdemeanors). Of the 1973 offenses known to police,

more than one-half were larceny theft, slightly over 15 percent were aggravated assault.

Finally, the Rosebud County roads in the vicinity of industrial activity are in terrible condition. Designed to handle moderate use, they are now being used as major industrial arterials and are also receiving heavy use by the increased population of the area.

To meet these demands the county has two major sources of tax revenues, in addition to normal county mill levies. These are the Net Proceeds Tax and a 3 cents per ton county share of the Coal Mines License Tax. However, the Net Proceeds Tax, paid by mining companies, allows a deduction for the costs of doing business (which includes land reclamation expenses). As a consequence, county officials have no way of predicting the income that will derive from that tax and must either limit expenses or make up the revenues in other taxes -- taxes paid by county residents, most of whom receive no direct benefits from coal development. Interestingly, while the Department of State Lands has estimated that reclamation can be accomplished at a cost of $700 per acre, all Rosebud County mining interests are claiming far greater expenses -- one company claims several times that amount. As a result, while coal production has increased, proportionate income from the Net Proceeds Tax has decreased.

One study conducted under auspices of the NGPRP (Williams, Patterson and Leland) has suggested the development of centralized county service centers in order to efficiently meet increased demand.

These centers would be staffed by professionals in relevant fields and would be supported by planning capabilities. Unfortunately, this approach requires considerable revenue, and time to accomplish -- both of which are now in short supply.

Effects Upon Life Styles

Gillette Syndrome: The term "Gillette Syndrome" was coined by a Wyoming clinical psychologist, ElDean Kohrs, and refers to a constallation of "deviant" behaviors noted in persons located in rural, western boom towns. In using this term, Kohrs often refers to the accompanying "4-D's" -- drunkenness, depression, deliquency and divorce. Crowded and unsanitary living conditions, lack of basic community services, lack of recreational outlets, lack of community identity, lack of permanence and long hours at what may be an unrewarding task -- all contribute to the development of the Gillette Syndrome. Kohrs also notes that suicide attempts (though rarely fatal) are very high. He also indicates that school drop-out rates are very high, that truancy is high, delinquency is common and that criminal facilities are overtaxed, in some cases because no other facilities are available (e.g., see Kohrs, 1974, Social Consequences of Boom Growth in Wyoming).

It is interesting to note that many of the characteristics of the boom towns Kohrs discusses are beginning to appear in the Colstrip area.

Anomie and Uncertainty: Gold has observed a growth in the occurrence of anomie among residents of the Colstrip area, whether locals or newcomers. ("Anomie" refers to a sense of anonymity, lack of identity or "belongingness" within individuals. The indidivual has no referent group with which to relate or against which to assess his self worth.)

Living and working conditions in the Colstrip area work against the establishment of permanent or lasting ties between individuals. The sense of impermanence in the area ("The whole town is on wheels - I expect to wake up some day and see half of it gone." Quote from Raymond Gold's paper.) makes such relationships impractical. In addition, the construction community at Colstrip is segregated into "manual" and "non-manual" sectors -- a Bechtel policy. While Western Energy and the Montana Power Company maintain that such segregation is not their policy, potential residents of the new permanent housing in Colstrip are very carefully screened. To date, only management or professional types occupy those buildings. In addition, since Colstrip is totally a company town, residents have no say or involvement in the conduct of community affairs. As a consequence, there is little for people to do in their off-hours, beyond drinking or watching television. Gold reports that many housewives in the construction area have become food and television addicts.

Locals have found many of their former ties to the old community ruptured by the newcomers. This, combined with the antagonism and resultant mutual avoidance that has come to characterize relationships

between those holding divergent views on development, has served only to increase feelings of isolation. Many locals report feeling that Colstrip is no longer their town and that they are strangers in the area in which they have spent their entire lives.

The isolation in which ranchers and other agricultural operators have come to work in the area has served to increase their feelings of uncertainty about the future. Those living in the area have typically felt that, except for the vagaries of nature (to which they have adapted), they were largely in control of the direction of their lives. With massive coal development on the horizon, and no specific information as to what to expect from the companies, the state and the federal government, this certainty has been lost. Instead, uncertainty, hesitancy, resignation and, in some cases, fear, are becoming the rule. In this atmosphere, rumor and suspicion become guiding factors in behavior. According to Gold, many persons in the development area are shaping their lives in response to quite distorted perceptions of reality, for lack of anything better. And, in this respect, the necessary characteristics of social interaction, trust, a sense of cooperation and responsibility, are becoming less common. Many residents report that much of the joy of their lives has been lost, to be replaced by hostility, suspicion of former acquaintances and friends, and a sense of having to fight everyone for survival. Some mention how they have been forced to lower their standards of what constitutes a quality life style, to accept bare survival in their chosen occupations.

Beyond this, the specific effects of growth in the area are being felt. People, town folk and ranchers alike, now report feeling it necessary to lock up their possessions for the first time in their lives. Some ranch children are singled out for abuse on school grounds. Women report feeling reluctant to go places alone, for the first time in their lives. Many local families report avoiding bars and other local gathering places because they are now potential objects of abuse and, in some cases, provoked fights.

Landowners report a contempt for property rights on the past of newcomers, with destructive trespass becoming common. Many complain of shady tactics on the part of land speculators and mining interests in this respect. Many such apparently take advantage of the size of some agricultural units to illegally survey or sample underlying coal seams on the chance that they won't get caught. Lies and deception are reported to be common practices of land speculators and mining interests in their attempts to put together sizeable leases. Other ranchers have reported harrassment by lessors when they oppose coal development.

Reflection on the impacts discussed previously, in the context of the historical remarks introducing this chapter, should provide another indication of the impacts of coal development upon Montanans. They have seen all this before. After finally having gained some control of their government and having begun to make it work for <u>all</u> interests within the state, Montanans are most reluctant, at best, to return to old ways. Montanans also are aware of the problems

that afflict other states in the nation and, sympathetic as they are, do not wish to see them duplicated here. They justifiably fear a massive influx of "outsiders", for what they value most about Montana is seldom held in high esteem by those newcomers. Montanans, by the nature of their state, have been forced to live somehwat less profligately than many of their fellow countrymen. They feel that many of the energy, materials and foods crises now afflicting the nation are inevitable and traceable directly to those profligate ways. They feel that the only realistic solution to those crises is a change in lifestyle, not simply a new approach to exploitation. Holding that conviction, Montanans do not wish to see their cherished state and cherished life style sacrificed only to postpone, for a short time, the nation's inevitable day of decision.

Natural Values

Montana is a unique state with a natural character that has evolved from rugged, if not violent, beginnings. Vast open spaces and untrammeled landscapes further contribute to the qualities that make up Montana. The state has an infectious allure that overwhelmed the Nobel Prize winning author, John Steinbeck, as he traversed its breadth.

> ". . . Montana is a great splash of grandeur. The scale is huge but not overpowering. The land is rich with grass and color, and the mountains are the kind I would create if mountains were ever put on my agenda. . . . the frantic bustle of America was not in Montana. . . . towns were places to live in rather than nervous hives. People had time to pause in their occupations to undertake the passing art of neighborliness." 30/

There is a special and pervasive closeness with the land in Montana. This closeness has been sustained because we have space -- space to have a life of meaning and substance. An eminent Montana historian, K. Ross Toole, has carefully examined the psyche of Montana and contrasts its being with the rest of America.

> "And so America grew by eating upon itself -- by devouring space, by devouring land. But there is no more land; there is no more space to devour. So, what we have left of what we once had has suddenly become precious. And it will become more so until it becomes infinitely precious because we cannot live without it . . ..
>
> Montana is graced with an abundance of that vanishing commodity. It cannot yet (if ever) be translated into dollars. It cannot be measured because it is a thing of the spirit. It cannot really be quantified because it is a quality." 31/

This then is Montana; a land of space and beauty, a land where life does not imply mere existence but rather a cherished thing of quality.

30/ Steinbeck, John, "Travels with Charley in Search of America," (New York: Bantam Books) 1962.

31/ Toole, K. Ross, "Twentieth Century Montana, A State of Extremes," (Norman, Oklahoma: University of Oklahoma Press) 1972, 307 pages.

Slow Population Growth

Nearly 700,000 people resided in Montana in 1970, an increase from 538,000 people in 1930. From 1950 to 1968, state population increased by 17 percent, which is slightly less than half the rate of the Rocky Mountain States as a group and slightly more than half the national growth rate. 32/

A population of 700,000 is low in comparison to that of other states. In the past, this figure, coupled with the rate of population growth, was a cause of concern. Today, people realize that low population and slow growth have spared the natural values of Montana from many of the environmental problems experienced in other areas -- but increases in population up to about one-half million have been projected from energy development alone. 33/ If so, the values attendant to a sparsely populated region -- clear air, open space recreation, abundant wildlife, an enviable life style, aesthetics -- would be diminished.

Economy

The economy of the state has been traditionally dependent on a natural resource base -- agriculture, minerals, forestry and, particularly in certain areas, recreation and tourism. Consequently, Montana

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32/ University of Montana, Bureau of Business and Economic Research, Montana Economic Study, Research Report, October 1970.

33/ Montana Coal Task Force, Coal Development In Eastern Montana, January 1973.

has not witnessed rapid industrial growth.

Agriculture continues to be Montana's largest basic industry, producing well over one billion dollars of incomes in 1973 and exceeding the combined marketing revenue of the state's next five largest industries.

Table VII-3: Valuation of Industries #2 Through #6

2.	Mining, including coal	$362.5 million
3.	Manufacturing	330.4 million
4.	Tourism	231.4 million
5.	Oil	104.0 million
6.	Lumber	85.3 million
		$1,113.6 million

Source: Sam Rosen, Mo.

The agriculture economy is compatible with and contributes greatly to the maintenance of many significant components of Montana's life style, including open space, wildlife habitat and clear air. Simultaneously, low population density is allowed, and an essential sustaining commodity, food, is provided.

Limited job opportunities and low income levels are the price paid for slow growth, but indications are that many residents are willing to accept less monetary reward in order to live in the quality environment of Montana and experience the western way of life.[34/]

34/ Montana Regional Land Use Conference, October and November 1974, Questionnaire Data.

To greatly expand both industry and agriculture in Montana is not possible, for there are too many competing demands for land and water. Because of the rural heritage and the tangible economic values and intangible environmental and social values provided, Montanans indicate a strong desire to continue the agricultural base and character of the state.

Land Resource

Montana, the nation's fourth largest state, averages 550 miles in length and 275 miles in width for a total of 93,217,000 acres or 145,651 square miles.[35/]

Ownership: Federal land management agencies administer 29.6 percent of Montana, and state agencies and institutions administer 6.5 percent. Indian reservation land makes up another 6.9 percent, while the remaining 57 percent is held in private ownership.

Energy development will alter the land ownership in the state, especially those areas where extensive coal reserves are found and where the surface rights and mineral rights are owned by separate parties. Presently, it is estimated that over one-half million acres of coal rights have been leased in Eastern Montana[36/] and it can be assumed

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35/ Montana Department of Planning and Economic Development, Montana Statistical Review, undated, 46 pages.

36/ Northern Great Plains Resource Program, Draft Report, Sept. 1974.

that much of the surface over these areas will ultimately be owned by the companies holding the coal rights as they prefer to acquire the surface rights as well.[37/]

Land Use: Land uses have been inventoried for 70 percent of Montana's land area, most of which consists of non-federal lands. A summary of the inventoried acreage is shown in Table VII-4 below.

Table VII-4 Inventory Acreage

	Acres	Percentage of Land Inventoried
Cropland	14,988,775	22
Range and pasture	43,005,287	66
Woodlands	7,003,910	11
Other lands */	520,205	1
Totals	65,518,178	100

*/ Other lands include farmsteads, private roads, feed lots, ditch banks, rural non-farm residences, mine wastes, barrow pits and investment tracts.

Dryland crops, mainly small grain and fallow, make up 89 percent of the cropland; the remainder is irrigated. Range and pasture land consists of 96 percent range and 4 percent pasture. Although rangeland is found throughout the state, it dominates the eastern prairies

37/ Solomon, Sharon, personal communication, November 26, 1974.

and is essentially all dryland. About one-third of the pasture land is irrigated. Woodlands are principally found in the western mountainous region. Commercial forests account for 87 percent of the inventoried acreage of woodland.[38/]

Trends: Montana is witnessing an intensification in use of the land. With each passing day, more forest, range, cropland and wildlife habitat is lost to urban sprawl, rural subdivision and second home recreation development, transmission lines, and a variety of other uses. In Eastern Montana, energy development and associated urban growth threaten the rural character and agricultural economy. If these trends continue at their present rate, serious effects can be expected on the long-run productivity of Montana's lands.

Energy Development: Approximately 1.4 million acres of Eastern Montana are considered strippable for subbituminous and lignite coal.[39/] The amount of this land that will be disturbed in the future is open to conjecture. However, the Northern Great Plains Resource Program has made projections for the Northern Great Plains Region which consists of the major coal fields of Montana, North Dakota, South Dakota, and Wyoming. A summary of those projections is shown in Table VII-5 on the following page.

38/ U.S. Department of Agriculture, Montana Conservation Needs Committee, Montana Soil and Water Conservation Needs Inventory, 1970, 172 pages.

39/ Northern Great Plains Resource Program, Draft Report, Sept. 1974.

Table VII-5: Land Impacted (In Acres) 1/ Total Northern Great Plains

	1980	2000	2035
Low Rate of Coal Production			
Mined land 2/	5,237	50,478	190,408
Plant facilities 3/	2,694	4,935	4,935
Ancillary facilities 4/		44,879	44,879
Totals	8,081	100,292	240,222
Intermediate Rate of Coal Production			
Mined land 2/	5,500	100,795	561,850
Plant facilities 3/	2,993	26,227	26,227
Ancillary facilities 4/		82,518	82,518
Totals	8,493	209,540	670,595
Maximum Rate of Coal Production			
Mined land 2/	10,938	227,705	1,303,920
Plant facilities 3/	9,200	59,330	59,330
Ancillary facilities 4/		109,890	109,890
Totals	20,138	396,925	1,473,140

1/ Acreages occupied by urban growth not determined.
2/ Acreages mined up to dates indicated.
3/ Acreages occupied with plants, yards and other facilities directly associated with plants and mines.
4/ Acreages occupied by railroads, highways, haul roads, transmission lines, aqueducts and reservoirs were calculated only to year 2000.

Source: Northern Great Plains Resource Program.

As shown in Table VII-6 below, Montana has 46.8 percent of the region's 68.1 billion tons of surface mineable coal reserve and 53.8 percent of the region's 2.6 million acres of land underlain by surface mineable coal reserves.

Table VI-6: Surface Mineable Coal Reserves and Acres Underlain in the Northern Great Plains

State	Reserves Mineable by Surface Methods (Billion of Tons)	Percentage	Acres Underlain by Surface Mineable Coal (Million of Acres)	Percentage
Montana	31.9	46.0	1.4	53.8
Wyoming	19.8	29.1	0.4	15.4
North Dakota	16.0	23.5	0.7	27.0
South Dakota	0.4	0.6	0.1	3.8
Totals	68.1	100.0	2.6	100.0

Source: Northern Great Plains Resource Program

If the above percentages are an indication of the amount of coal development Montana may experience, then it can be surmised that about 50 percent of the acreage disturbed figures in Table VII-5 may occur in Montana

Regardless of the specific acreage figure, the potential surface disturbance possible by coal strip mining, energy conversion plants, highways and roads, transmission lines, reservoirs and aqueducts is large. Also, it must be emphasized, the NGPRP did not attempt to

estimate surface acres required for the urban development associated with such industrialization, therefore Table VII-5 does not reflect urban development.

Mined land disturbance, unlike those surface disturbances associated with energy conversion plants, associated ancillary facilities and urban growth are considered by many as short term if rehabilitated. However, "no lands have been revegetated for sufficient time or with sufficient variety of native species to determine potential for success," and certain areas such as streambottoms and badlands may not be restored to any resemblance of their original condition.40/

Water Use

Irrigation accounts for 98 percent of all water consumed in Montana, and surface water is the primary source of supply. Municipal, industrial, rural domestic and livestock watering account for the remaining two percent.

Irrigation: Over three million acre feet of water is needed annually for irrigation, which requires a diversion of 12.4 million acre feet to assure the necessary water in the field. In general, peak water requirements are during the July and August growing season, when streamflows are low. During this period, water supplies are insufficient in many areas.

40/ Northern Great Plains Resource Program, Draft Report, Sept. 1974.

Currently, water is used to produce crops on over 2.5 million acres of agricultural land, but this figure decreases by as much as 300,000 acres in dry years. The land developed by federal and state irrigation projects totals an estimated 900,000 acres, leaving about 1.6 million acres of private irrigation development in the state.

An additional 11.5 million acres are potentially irrigable in Montana, but the amount of that acreage which will actually be developed is already limited by water availability. Further restrictions come about because of competing land and water uses. For example, irrigable and irrigated lands, especially along populated river valleys, are being lost to urban sprawl and the proliferation of rural subdivisions.[41/]

Energy Development: Energy development, if it proceeds at the scale projected, will need massive quantities of water from the Yellowstone and other river basins of Eastern Montana. Already, pressure for water for this purpose is far greater than anticipated. For example, in 1972, the Bureau of Reclamation's Montana-Wyoming Aqueduct Study projected a water demand of 2.6 million acre feet annually by the year 2002.[42/] Two years have passed, but options,

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41/ Montana Department of Natural Resources and Conservation, Water Resources Division, The Framework Report, A Comprehensive Water And Related Land Resources Plan for the State of Montana, (unpublished draft report of the Water Planning Bureau) 1973.

42/ U.S. Department of Interior, Bureau of Reclamation, Report on Yellowstone Division, Missouri River Basin Project, Appendix B, Water Supply, 1962.

applications and requests for industrial water in the Montana portion of the Yellowstone Basin have already approached that figure, totaling over 2 million acre feet.[43/]

As shown in Table VII-7 below, 2 million acre feet of water annually from the Yellowstone Basin is twice the amount of water projected by the NGPRP for high coal use in the year 2000 in the entire Northern Great Plains Region.

Table VII-7: Northern Great Plains Coal Development
Related Water Depletions for Year 2000 With Maximum Coal Use

	Acre Feet
Coal conversion	543,000
Municipal	69,300
Revegetation	41,200
Slurry pipeline */	186,900
Total	800,400

*/ Assumes 50 percent if exported coal shipped by slurry pipeline.

Source: Northern Plains Resource Council

Obviously, either much speculation is taking place or water demands for energy-related purposes will be higher than anticipated.

Although, in an average year, 9 million acre feet flow from the Yellowstone Basin, the lowest annual discharge on record was 4.2 million

43/ Water Resources Division, Montana Department of Natural Resources and Conservation, nonpublished data, undated.

acre feet.[44] Large demands threaten to foreclose future agricultural options by appropriating all excess waters and by driving the price of water beyond the means of irrigators. Furthermore, such demands, if granted, could exceed critical minimum flows and jeopardize existing rights.

The water demands for energy development have been an important catalyst, shocking Montanans into a heightened awareness of the importance of water, not only for agiculture, wildlife, forests and livestock, but also for a way of life that has long since come to an end in much of the nation.

Water Quality[45]

Generally, the surface waters of the state are rated from good to excellent in both chemical and bacterial quality. Exceptions include local bacterial contamination from municipal and feedlot discharges, chemical and toxicity problems from mining and petroleum operations, and suspended sediments from improper land use activities. In the localized areas where pollution has occurred, deterioration of the quality of water supplies, damage to fish habitat, and diminished aesthetic values have resulted. However, disregarding

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44/ U.S. Department of Interior, Bureau of Reclamation, Report on Yellowstone Division, Missouri River Basin Project, Appendix B, Water Supply, 1962.

45/ Montana Department of Natural Resources and Conservation, Water Resources Division, The Framework Report, A Comprehensive Water and Related Land Resources Plan for the State of Montana, (unpublished draft report of the Water Planning Bureau) 1973.

localized problems, water quality is very good in comparison to that in other areas of the country.

Given projected increases in energy resource demands and associated growing populations, many factors may detrimentally affect water quality. Consequences could include runoff and seepage from mines, thermal pollution, decreases in low base flows, increases in dissolved solids, including trace elements, and sedimentation from exposure of large amounts of earthen materials.

Montanans strongly desire to maintain or improve present water quality. However, if the state's future includes rapid growth and industrialization, this may be impossible -- judging from the industrialized areas of the nation.

Fish and Wildlife

Montana is generously blessed with high quality fish and game habitat, and wildlife is an important part of the heritage of the state. Of the state's 94 million acres, most land not urbanized provides a variety of habitat.

Present Standing - Fisheries: The opportunity for high quality, uncrowded fishing amidst scenic surroundings is an outstanding characteristic of the state, and residents and visitors spend approximately

2.6 million days annually fishing in Montana.[46] Fisheries habitat include approximately 15,000 miles of streams, of which 1,441 miles have been identified as prime trout streams and 1,344 miles are warm water streams.[47] The remaining flowing waters afford excellent to fair fisheries. In addition, stored water furnishes habitat for various species.

The rivers and streams of the Yellowstone, Missouri, Clark Fork and Kootenai River Basins harbor trout (cutthroat, eastern brook, rainbow, brown and Dolly Varden), salmon of the landlocked variety, whitefish and grayling. Warm water species of the lower reaches of the Missouri and Yellowstone Rivers include sauger, walleye and northern pike, sunfish, crappie, yellow perch and the prehistoric paddlefish.

Present Standing -- Big Game Animals: Montana, a land of great expanse and few people, provides wildlife a diversity of habitat -- prairies, mountains and river valleys. The most common game species, and with the widest distribution, is the mule deer. White-tailed deer are found in Northwestern Montana, in the foothills of Central Montana and along the river valleys. Elk, less tolerate of man, are distributed

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46/ McConnen, Richard J., "Economic Importance of Hunting and Fishing in Montana", Montana State University, Bozeman, 1960.

47/ Montana Department of Natural Resources and Conservation, Water Resources Division, "The Framework Report, a Comprehensive Water and Related Land Resources Plan for the State of Montana," (unpublished draft report of the Water Planning Bureau) 1973.

principally in the forested areas of the montane and piedmont regions. Moose, with expanding distributions, are now common in Northwestern and Southwestern Montana. Pronghorn antelope, found in prairie habitat, are distributed almost throughout the state. Big horn sheep now mainly inhabit the mountain ranges, as do Rocky Mountain goats. Black bear populations are sizeable in their native habitat in the western part of the state.

Montana has the largest remaining grizzly bear population in the nation, with the exception of Alaska. Whereas other, more developed western states like Arizona, California, and New Mexico have lost the grizzly, Montana, with precious wilderness and roadless lands, offers a refuge to this majestic and rare animal. However, even in Montana the grizzly has been forced from the plains.

Present Standing -- Game Birds: Ten species of upland game birds occur in Montana. The six species native to the state are white-tailed ptarmigan, spruce (Franklin's) grouse, ruffed grouse, blue grouse, sharp-tailed grouse and sage grouse. Introduced species include ring-necked pheasant, Hungarian (grey) partridge, Merriman's turkey and chukar partridge.

Present Standing -- Waterfowl: Duck population densities in certain areas, especially the lower Flathead Valley and the northern glaciated prairies of Eastern Montana, compare favorably with the best in the continent. Mountain areas, with many streams, lakes and

beaver dams, supplement the number of breeding waterfowl.

The future for the waterfowl resource in Montana is promising, even though habitat has suffered from man-made changes. Marsh lands and potholes have been drained and filled to make land more suitable for man's uses. Impoundments and alterations of natural stream channels have also reduced habitat.

Numerous wildlife refuges, lakes and ponds within the state serve as nesting sites.

Waterfowl are considered an international resource. Birds from two flyways pass through Montana, and across state and national boundaries between nesting and wintering areas. The important migratory birds are ducks, mergansers, geese and swans. Of the 48 species in this family on the north american continent, 33 species have been recorded in Montana (2 of swans, 5 of geese, 3 of mergansers and 23 of ducks).[48/]

Montana is situated on the edge of the finest waterfowl breeding range in North America.

Present Standing -- Endangered Species: Montana harbors vestiges of four endangered species, the American peregrine falcon, the whooping crane, the Northern Rocky Mountain wolf and the black-footed ferret. The future of these species is totally dependent on man's sensitivity.

48/ Montana Department of Fish and Game, Game Management in Montana, edited by Thomas W. Mussehl and F. W. Howell, 1971, 238 pages.

Present Standing -- Prospects: Habitat is crucial in maintaining viable fish and wildlife populations; therefore, careful consideration must be given to preserving habitat in land and water management decisions.

Energy development in Eastern Montana will result in the direct loss in habitat from mining and associated facilities and indirectly from increased populations requiring urban development. Increased populations will also mean larger numbers of hunters who will put additional hunting pressure on all game species throughout the state and region.

NGPRP assessed the impacts of energy development on the Northern Plains wildlife. Some of their regional findings based on the maximum coal development alternative for the year 2000 are: Loss of 400,000 acres of wildlife, including 277,000 acres of deer habitat and 83,000 acres of turkey habitat. An increase in 69,000 deer hunters and 29,000 more resident elk hunters. Birds of prey will lose 295,000 acres of hunting grounds and will be subject to intentional and unintentional persecution by about .5 million more people. Local populations of passerine birds will be eliminated, as will some local populations of endangered and threatened species. 49/

The continuation of productive fisheries depends upon adequate quantities of high quality natural flowing water. The pressures of

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49/ Northern Great Plains Resource Program, Draft Report, Sept. 1974.

of energy development will make the maintenance of these conditions more difficult.

The constant pressure to derive short-term profit from the land could extract an irreversible price -- for both wildlife and future generations. As the eminent ecologist, Aldo Leopold, said: "Harmony with the land is like harmony with a friend; you cannot cherish his right hand and chop off his left."[50/]

Recreation

Montana, a land of diverse landscapes, varied seasons and abundant wildlife, provides numerous outdoor recreation activities in settings of exceptional beauty, spaciousness and wildness. As the seasons change, so do the opportunities for recreational pursuits. Summer activities dependent on warm weather, like swimming, hiking, boating, camping and fishing, give way to the enjoyment of big game and waterfowl hunting in the fall, and the winter's snow allows a variety of outdoor recreation.

A major component of Montana's economy, outdoor recreation is, but of greater importance than dollars are the unquantifiable natural values themselves. These values include variety, beauty, wildness,

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50/ Montana Department of Fish and Game, Game Management in Montana, edited by Thomas W. Mussehl and F. W. Howell, 1971, 238 pages.

wildlife, clean air, unpolluted streams, and relief from congestion -- all contributing to the enhanced man-nature relationship that seems to exist in the state. Such qualities are priceless common resources that must be shared and preserved, but protection is becoming difficult. Even the use and enjoyment of the natural environment tends to affect its quality.

For the past 30 years, use of the outdoors has increased. Greater mobility, leisure and income, together with expanding numbers of people, have created this upswing while concurrently threatening Montana's recreational values. Campgrounds are often congested. Prime trout habitat is being lost to rip-rapping, dewatering, channelization and sometimes pollution. Marketing of second home sites in undeveloped areas is increasing, which tends to diminish diverse natural landscapes supporting wildlife and replace them with open space consuming, resource depleting sprawl. The list of threats to quality outdoor environment is long and growing.

In the future, Montana expects greater use and appreciation of the outdoors by residents and visitors. If the state becomes industrialized in response to national demands, then additional pressures will result, possibly in such a magnitude that, even with restrictions, our natural beauty and quality of life will be degraded. In turn, Montana's outstanding recreational opportunities will be diminished.

Conclusion

Energy industrialization, although a relative newcomer industry in Montana, represents an ominous force which can radically change the natural character of the entire state. Conversion plants, strip mines, urban build-up and transmission lines will impact nearly every area of the state.

This possibility of industrialization comes at a time when Montanans and, indeed, all citizens, are more aware of the personal and societal values of a natural, unpolluted and uncrowded environment and Montanans have expressed little desire for rapid population growth (Montana Regional Land Use Conference, 1974).

Consequently, energy industrialization of Montana has emerged as a principal state issue, the resolution of which will largely determine the character of much of Montana and the quality of life it affords.

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CHAPTER VIII

SUMMARY AND CONCLUSIONS

Summary

This study has shown that energy has played a significant role in the productive and consumptive activities of the Montana economy, as a factor or production and as a consumer good. Furthermore, the production of energy -- from the construction of hydropower dams to the extraction and refining of mineral fuels -- has contributed to employment, incomes and tax revenues. There have undoubtedly been social and economic costs as well.

Looking toward the future and thinking strictly in terms of energy, we see coal -- far exceeding any other energy-related activity -- as having the greatest potential for influencing Montana's economy (and society as well). For this reason, much of this report dwells upon coal-based activities.

The accompanying Table from Chapter II briefly summarizes the coal development scenarios and the associated population and employment levels.

Table VIII-1

ALTERNATIVE FUTURE SCENARIOS, THE ROLE OF ENERGY AND MINERAL FUELS IN THE MONTANA ECONOMY

		SCENARIO I Virtually No Coal Development	SCENARIO II Middle Range of Coal Development (NGPRP)	SCENARIO III Large-Scale Coal Development (NGPRP)
1970	Coal Production (10.6 Million Tons Per Year)	3.48	----	----
	Coal-Fired Generation on Line (MW Capacity)	230	----	----
	Coal Gasification on Line (MMCFD Capacity)	0	----	----
	Total Population	694,409	----	----
	Total Employment	248,342	----	----
1980	Coal Production	3.5	41	64
	Coal-Fired Generation	230	2,050	2,050
	Coal Gasification	0	0	750
	Total Population	740,128	760,128	797,128
	Total Employment	261,320	270,300	291,300
1985	Coal Production	3.5	75	153
	Coal-Fired Generation	230	2,500	2,500
	Coal Gasification	0	750	2,000
	Total Population	761,573	817,573	841,573
	Total Employment	271,088	298,100	307,100
2000	Coal Production	3.5	133	393
	Coal-Fired Generation	230	6,360	6,360
	Coal Gasification	0	1,500	3,750
	Total Population	825,910	889,910	969,910
	Total Employment	301,563	325,600	357,600

Other pertinent findings are:

The cost of setting up a strip coal mine in Montana has virtually doubled since 1969. The majority of capital expenditures for coal-based development either go directly out of state or through one distributor on their way out of state.

The most significant factors in coal industry location decisions are strictly natural resource oriented. Although this is not surprising, it is somewhat disappointing in light of the social systems and other human values at stake.

If coal development occurs as anticipated, tax revenues will increase. There is no assurance, however, that in the near time horizon these revenues will meet government expenditures necessitated by energy development.

Coal development, depending on timing, spatial distribution, and individual characteristics, can potentially have a significant effect on both surface and groundwater, large acres of land surface, and air quality. Agicultural and tourism-recreation enterprizes will be displaced.

Conclusions

After carefully looking at the role of energy and mineral fuels in the Montana economy from an economic perspective, one important observation stands out. Although economic factors are

important, they clearly do not tell the whole story. If one is faced with weighing the pros and cons of a given activity in a specific area, he must first estimate the economic impacts appropriate to the activity and impact area under consideration. Then he must look beyond economics to the long-term effects on human and natural values. Cultural disruption, social dissolution, reduction in the quality of education, environmental pollution, loss of agricultural land, etc., are extremely important to those living in the area. A strictly economic assessment in the narrow traditional sense will not consider these broad factors. Making a decision on such a narrow base does the public a sore disservice.

The aggregation of economic impacts to the state level can be dangerously misleading. A one percent change in the state population may be virtually insignificant at the state level, but if it takes place in one rural county it could easily double the county population. And doubling the population of a rural Montana county in one or two years cannot be considered insignificant in any sense of the word.

If one is concerned with local development and localized impacts, he must look very closely at the specifics of the expected activity.

Lastly, we hope the reader will recognize this study as a survey report. Obviously the detail needed to make very specific

decisions was beyond the scope of this particular study. We hope the new data presented and our overviews will be useful to concerned citizens and decision-makers alike.

SURVEY FORM FOR COAL COMPANIES

1. Please rank the following factors in decreasing order of importance to decisions to locate a coal mine in the Northern Great Plains Region. A rank of 1 would be assigned to the most important factor, a rank of 10 the least important. If any of the factors are equally important, please so inform us in the "Remarks" space below. Please identify any important factors we have omitted.

Rank	Factor
____	Proximity to market.
____	Transportation cost and availability.
____	Quantity of coal.
____	Quality of coal (BTU rating, sulfur content, etc.).
____	Overburden characteristics.
____	Tax structure (corporate taxes, coal taxes).
____	Reclamation laws.
____	Possibility of future mine mouth energy conversion.
____	Availability of leases (mineral rights).
____	Public opinion.

Remarks: _____

_____

_____

_____

_____

2. Please rank the following factors in decreasing order of importance to decisions to locate a coal mine at a specific site within the Northern Great Plains Region. A rank of 1 would be assigned to the most important factor, a rank of 10 the least important. If any of the factors are equally important, please so inform us in the "Remarks" space below. Please identify any important factors we have omitted.

Rank	Factor
____	Proximity to market.
____	Transportation cost and availability.
____	Quantity of coal.
____	Quality of coal (BTU rating, sulfur content, etc.).
____	Overburden characteristics.
____	Tax structure (corporate taxes, coal taxes).
____	Reclamation laws.
____	Possibility of future mine mouth energy conversion.
____	Availability of leases (mineral rights).
____	Public opinion.

Remarks: _____

_____

_____

_____

_____

SURVEY FORM FOR ENERGY CONVERSION COMPANIES

1. Please rank the following factors in decreasing order of importance to decisions to locate an energy conversion facility in the Northern Great Plains Region. A rank of 1 would be assigned to the most important factor, a rank of 13 the least important. If any of the factors are equally important, please so inform us in the "Remarks" space below. Please identify any important factors we have omitted.

Type of facility proposed: _____ Electric power generation.

_____ Coal gasification.

_____ Other (specify) _____

Rank	Factor
____	Proximity to market.
____	Transportation cost and availability.
____	Coal requirements (quality and quantity).
____	Water requirements.
____	Labor availability.
____	Availability of community services.
____	Siting regulations.
____	Environmental laws (air quality, reclamation, etc.).
____	Existence of transmission corridors, pipelines.
____	Tax structure (coal and corporate taxes).
____	Supply of construction, operation materials.
____	Land requirements.
____	Community or regional acceptance of a proposed project.

Remarks: _____

_____

_____

_____

2. Please rank the following factors in decreasing order of importance to decisions to locate an energy conversion facility at a specific site in the Northern Great Plains Region. A rank of 1 would be assigned to the most important factor, a rank of 13 the least important. If any of the factors are equally important, please so inform us in the "Remarks" space below. Please identify any important factors we have omitted.

Type of facility proposed: ____ Electric power generation.

____ Coal gasification.

____ Other (specify) _____

Rank	Factor
____	Proximity to market.
____	Transportation cost and availability.
____	Coal requirements (quality and quantity).
____	Water requirements.
____	Labor availability.
____	Availability of community services.
____	Siting regulations.
____	Environmental laws (air quality, reclamation, etc.).
____	Existence of transmission corridors, pipelines.
____	Tax structure (coal and corporate taxes).
____	Supply of construction, operation materials.
____	Land requirements.
____	Community or regional acceptance of a proposed project.

Remarks: _____

_____

_____

_____

_____

3. Please rank the following factors in decreasing order of importance to decisions to locate an energy conversion facility either at a mine mouth site or at a load center. A rank of 1 would be assigned to the most important factor, a rank of 7 to the least important. If any of the factors are equally important, please so inform us in the "Remarks" space below. Please identify any important factors we have omitted.

Type of facility proposed: ____ Electric power generation.

____ Coal gasification.

____ Other (specify) _____

Rank	Factor
____	Community acceptance of the plant (at mine mouth and load center).
____	Transportation availability and cost.
____	Environmental laws (at both locations).
____	Siting laws (at both locations).
____	Water availability (at both locations).
____	Labor availability (at both locations).
____	Availability of community services (both during construction and during operations).

Remarks: _____

_____

_____

_____

_____

_____

Utah International Inc.
Attn: Mr. R. O. Weaton
Manager of Exploration
550 California Street
San Francisco, CA. 94104

Central Montana Electric Generation
and Transmission Cooperative, Inc.
Attn: Mr. Rod Hanson
Executive Secretary
Box 217
Fairfield, Mt. 59436

Montana Power Company
Attn: Mr. John Ross
Environmental Attorney
40 East Broadway
Butte, Mt. 59701

The Washington Water Power Company
Attn: Mr. R. L. Strenge
P.O. Box 3727
Spokane, Wa. 99220

Montana-Dakota Utilities Company
Attn: Mr. W. W. Kroeber
Vice President, Electric
400 N. Fourth Street
Bismarck, N.D. 58501

Puget Sound Power & Light Company
Attn: Mr. D. H. Knight
Vice President, Power Supply
Puget Power Building
Glencourt 4-6363
Bellevue, Wa. 98009

Kerr-McGee Coal Corporation
Attn: Mr. F. A. McPherson
President
Kerr-McGee Center
Oklahoma City, Ok. 73125

Exxon Company, U.S.A.
Attn: Mr. B. D. Nolan
Billings Refinery Manager
P.O. Box 1163
Billings, Mt. 59103

Chevron Oil Company
Attn: Mr. W. A. Burton
Manager, Contract and Titles
1700 Broadway
P.O. Box 599
Denver, Co. 80201

Shell Oil Company
Attn: Mr. N. J. Isto
Manager Mining, Mining Ventures
Two Shell Plaza
P.O. Box 2099
Houston, Tx. 77001

Union Oil Company of California
Attn: Mr. John M. Hopkins
Vice President, Refining and Marketing
Union Oil Center
Box 7600
Los Angeles, Ca. 90051

Gary Operating Company
Attn: Mr. Fred A. Haddenhorst
Production Manager
Suite 1210, Denver Center Building
1776 Lincoln Street
Denver, Co. 80203

Northern Natural Gas Company
Attn: Mr. Royce W. Beck
District Manager
2223 Dodge Street
Omaha, Nb. 68102

United States Steel Corporation
Attn: Mr. J. S. Steel
Director Lands, Minerals and Timber
600 Grant Street
Pittsburgh, Pa. 15230

Shelby Gas Association
Attn: Mr. W. L. Current
Manager
Box 729
Shelby, Mt. 59474

Thunderbird Resources, Inc.
Attn: Mr. A. H. Morris
Refinery Manager
Big West Oil Company
Refining Division
Kevin, Mt. 59454

Vickers Energy Corporation
Attn: Mr. T. L. Kirby
Assistant to the President,
Energy Development
Suite 2300, 1700 Broadway
Denver, Co. 80202

Ark Land Company
Attn: Mr. Fred R. Burkhardt
Chief Engineer, Western Division
500 North Broadway
St. Louis, Mo. 63102

Amax Coal Company
Attn: Mr. C. W. Porterfield
Vice President - Engineering
105 South Meridian Street
Indianapolis, In.

Concho Petroleum Company
Attn: Mr, Rix M. Richardson, Jr.
Vice President
1222 Fidelity Union Life Building
1511 Bryan Street
Dallas, Tx. 75201

Pacific Gas and Electric Company
Attn: Mr. E. E. Hall
Chief Siting Engineer
77 Beale Street
San Francisco, Ca. 94106

Portland General Electric Company
Attn: Mr. A. J. Porter
Senior Vice President
Electric Building
Portland, Or. 97205

Conoco
Attn: Mr. G. R. Countryman
Continental Oil Company
152 North Durbin
Pacific Western Life Building
Casper, Wy. 82601

Pacific Power & Light Company
Attn: Mr. G. E. Drennan
Vice President
Public Service Building
Portland, Oregon 97204

Synethic Crude and Minerals Division
Attn: Frederick R. Scheerer
Atlantic Richfield Company
1500 Security Life Bldg.
Denver, CO 80202

Mid-West Electric Consumers Assn.
Attn: Fred G. Simonton
Executive Director
Executive Office Bldg.
Suite 300
P.O. Box 910
Evergreen, CO 80439

American Mining Congress
Attn: Don Sullivan
Ring Bldg.
Washington, DC 20036

Natural Gas Pipeline Company
of America
Attn: Harry Sutherland
122 South Michigan Ave.
Chicago, IL 60603

Hecla Mining Company
Attn: Walter W. Weid, Engineer
Box 722
Osburn, ID 83849

American Colloid Company
Attn: Boyd Klinger
Corporate Mineral Manager
Belle Fourche, SD 57717

Old Ben Coal Corporation
Attn: O. D. McDaniel, Manager
Planning & Development
10 South Riverside Plaza
Chicago, IL 60606

Kennecott Copper Corporation
Attn: S. D. Michaelson
Chief Engineer
Metal Mining Division
P.O. Box 11299
Salt Lake City, UT 84111

Getty Oil Company
Attn: D. A. Nichols
Division Minerals Land Manager
P.O. Box 54050 Term Annex
Los Angeles, CA 90054

Wyoming-Ben Products, Inc.
Mining & Properties
Attn: Chris J. Paustian
Vice President
P.O. Box 529
Greybull, WY 82426

Panhandle Eastern Pipeline Co.
Attn: L. E. Hanna
P.O. Box 1348
Kansas City, MO 64141

American Smelting & Refining Co
Attn: M. B. Hecox, esq.,
Assistant General Counsel
120 Broadway
New York NY 10005

Kaiser Engineers
Attn: Carl W. Horst
Senior Project Engineer
300 Lakeside Drive
Oakland, CA 94612

Island Creek Coal Company
Attn: W. L. Hush
Manager Exploration
3124 F. Avenue
Billings, MT 59101

Northern Natural Gas Company
Attn: Frank Kennedy
2223 Dodge St.
Omaha, NE 68102

Mobil Oil Company
Attn: Burns H. Errebo
150 East 42nd St.
New York, NY 75221

Kaiser Steel Corporation
Attn: James E. Good, Esq.
Counsel
300 Lakeside Drive
P.O. Box 58
Oakland, CA 94612

Tenneco Coal
Attn: Jack Gregory
P.O. Box 2511
Houston, TX 77001

Knife River Coal
Attn: Thomas Gwynn
400 North 4th St.
Bismarck, ND 58501

Bunker Hill Company
Attn: James H. Halley
Executive Vice President
P.O. Box 29
Kellogg, ID 83837

Imperial Coal Company
Attn: George A. Brennan
President
1010 Western Federal Savings Bldg.
Denver, CO 80202

American Natural Gas Service Company
Attn: A. E. Browning
One Woodward Ave.
Detroit, MI 48226

Gulf Mineral Resources
Attn:. Allen Crow
1780 South Bellaire Street
Denver, CO 80222

Consolidation Coal Co.
Attn: Charles Curb, Esq.
One Olwer Plaza
Pittsburgh, PA 15222

Energy Fuels Company
Attn: Harrison Eileljorg
President
Highway 287 & Laurel St.
Bloomfield, CO 80020

North American Coal Corporation
Attn: Otes Bennett, Jr. President
12800 Shaker Boulevard
Cleveland, OH 44120

Pacific Power & Light Company
Attn: Dick Blankenship
P.O. Box 720
Casper, WY 82601

Eastern Associated Coal Corp.
Attn: Thomas E. Boettyer, Esq.
1700 Koppers Bldg.
Pittsburgh, PA 15219

The Pittsburg & Midway Coal Mining
Attn: James A. Borders, President
Ten Main Center
Kansas City, MO 64105

Amax Coal Company
Attn: Irwin Reiso
105 South Meridian St.
Indianapolis, IN 46225

Reynolds International & Company
Attn: J. Louis Reynolds
P.O. Box 27002
Richmond, VA 23261

El Paso Natural Gas Company
Attn: C. A. Ross
El Paso, TX

J. R. Sumplot Company
Attn: M. Alsager
Environmental Control Coordinator
P.O. Box 2777
Boise, ID 82701

Panhandle Eastern Pipeline Company
Attn: Ken Anull
P.O. Box 1642
Houston, TX 77001

Peter Kiewit Sono Company
Attn: J. F. Ratchye
Mining District, Box 746
Sheridan, WY 82801

Lone Star Gas Company
Attn: George R. Rathburn
301 S. Harwood St.
Dallas, TX 75201

The Kemmerer Coal Company
Attn: Dr. Galen Reese
Environmental Control Engineer
Frontier, WY 83121

Getty Oil Company
Attn: Kenneth M. Reim
Division Project Geologist
3810 Wilshire Boulevard
Los Angles, CA 90010

Minnhota Power Cooperative, Inc.
Attn: Andrew Freeman
Box 1318
Grand Forks, ND 58201

North American Coal Corporation
Attn: J. J. Jedlicka
16800 Shaker Boulevard
Cleveland, OH 44120

Investor Owned Electric Companies
Attn: Bill Johnson
P.O. Box 247
Pierre, SD 57501

Peabody Coal Company
Attn: James R. Jones
301 North Memerial Drive
St. Louis, MO 63102

Knife River Coal Mining Company
Attn: Dr. David A. Jordon
400 North Fourth Street
Bismarck, ND 58501

The Nokota Company
Attn: Galen E. Anderson
President
P.O. Box 1633
Bismarck, ND 58501

Utah International, Inc.
Domestic Mining Operations
Attn: John S. Anderson
Vice President & Manager
550 California St.
San Francisco, CA 94104

American Metal Climax, Inc.
Attn: Stanley Anthony
2705 Montana Ave. Suite 350
Billings, MT 59103

Black Hills Power & Light Company
Attn: Robert G. Asheim
Executive Vice President
P.O. Box 1951
Rapid City, SD 57701

National Coal Association
Attn: Carl E. Bagge, President
1130 17th Street N.W.
Washington, DC 20026

Basin Electric Power Cooperative, Inc.
Provident Life Bldg.
Bismarck, ND 58501

El Paso Natural Gas Company
Attn: Terry Bauer
Synfuels Services
P.O. Box 990
Farmington, NM 87401

National Coal Association
Atlantic Richfield
Attn: Brooke Beatrel
316 S. Gillett Avenue
Gillett, WY 82716

Bear Coal Company
Attn: William A. Bear
General Manager
Somerset, CO 81434

Lovilla Coal Company
Attn: Tom Wignall
President
RFD 2
Melrose, IA 52560

EXXON Company, USA
Highland Uranium Operations
Attn: Morris T. Worley
Manager
P.O. Box 3020
Casper, WY 82601

Westmoreland Coal Company
Attn: Minturn T. Wright III, Esq.
123 South Broad Street
Philadelphia, PA 19109